PUBLISHED EVERY SATURDAY BY
THE W. J. JOHNSTON COMPANY, Limited.
41 PARK ROW (TIMES BUILDING), NEW YORK.
Established 1874. Incorporated 1889.
Telephone Call: Cortlandt 924. Cable Address: "Electrical," New York.

New England Office, 620 Atlantic Ave., Boston.
Western Office, 936 Monadnock Block, Chicago.
Philadelphia Office, 927 Chestnut Street.

SUBSCRIPTION IN ADVANCE, ONE YEAR, $3.
(Including Postage in the U. S., Canada or Mexico.)

In requesting your address changed, give **old** *as well as new address.*

ESTABLISHED 19 YEARS AGO, THE ELECTRICAL WORLD is the Pioneer Electrical Journal of America, and has well maintained its lead. It has the LARGEST CIRCULATION of any electrical periodical in the world, and is the BEST ADVERTISING MEDIUM.

In the growth of THE ELECTRICAL WORLD, in circulation, size and general improvement, the **value of its columns for reaching those engaged in electrical pursuits** has not failed to be **appreciated by advertisers.**

The following table shows **the steady onward march** of the paper in this department of its business, notwithstanding the numerous recent consolidations among electrical companies:

The first issue of 1881 contained	28	different	adv'ts.	1888 cont'ined	175	different	adv'ts.
1882 "	45	"	"	1889 "	234	"	"
1883 "	63	"	"	1890 "	289	"	"
1884 "	82	"	"	1891 "	325	"	"
1885 "	100	"	"	1892 "	316	"	"
1886 "	138	"	"	1893 "	317	"	"
1887 "	154	"	"				

No announcements of the Publisher are included in this list.

CIRCULATION.

Of no issue of The Electrical World for years have fewer than 9,000 copies been printed and published, while for a long time no issue has consisted of less than 10,000 copies, and the number of copies actually printed and published has of late in many instances reached 11,500. Mr. Johnston holds himself personally responsible for the accuracy of these figures and for the statement that no other electrical journal in America, or in Europe, or in the world, regularly issues one-third as many copies.

"WANT" AND "FOR SALE" ADVERTISEMENTS

are a special feature of **THE ELECTRICAL WORLD.** Position Wanted small advertisements cost but $1 an insertion; Help Wanted and For Sale small advertisements cost but $1.50 an insertion. Remit in advance for the number of insertions desired.

THE ELECTRICAL WORLD'S Advertising Rates are much lower than those of any other similar publication, circulation and standing considered, and vary according to space, position and number of insertions. Quotations promptly furnished.

Address and make drafts, orders, etc., payable to

THE ELECTRICAL WORLD,
41 Park Row, New York,
OR ANY OF THE BRANCH OFFICES.

Special Notice.—*The Western office of The Electrical World, which has for several years been located at 465 The Rookery, Chicago, will hereafter be found at 936 Monadnock Block, where larger, more convenient and more cheerful quarters have been obtained in the new wing known as "Section C." This addition to the original building is really not yet entirely completed in its internal arrangements. For instance, the elevator which is to run in front of The Electrical World's office will not be in commission for several weeks, but in the meantime one of the other elevators, of which there are a dozen or so, can be taken to the ninth floor. It is to be hoped that the Chicago friends of The Electrical World and those visiting the World's Fair city will make a point of visiting the office, where they can always rely upon a cordial welcome.*

VOL. XXI. NEW YORK, MAY 20, 1893. NO. 20

CONTENTS.

EDITORIAL: PAGE
Paragraphs ... 369
ILLUSTRATED ARTICLES:
Earth Currents, by T. Kennedy Gibson ... 370
Conductors and Insulators—VI., by Reginald A. Fessenden ... 372
The Great Switchboard of the Westinghouse Exhibit ... 374
The Prismatic Incandescent Bulb on the Edison Light Tower at the World's Fair ... 380
Duplex Electric Sinking Pump ... 380
The Lundell Ceiling Fan Motor ... 380
The H. N. H. Fan Motor ... 380
MISCELLANEOUS:
Unjust Law ... 370
Pennock Bobs Up Again ... 370
The State Executioner ... 370
New Books ... 370
The Westinghouse Charges Against the General Electric Company ... 371
On the Proposed Practical Magnetic Units, by A. E. Kennedy ... 371
Non-Synchronous Alternating Current Motors—II., by Dr. Behn-Eschenburg ... 372
Municipal Electric Plants ... 373
Currents from Commercial Circuits for Medical Purposes, by H. E. Waite, M. D ... 377
Automatic Electric Switch and Signal System on the Reading R. R. ... 377
The Electrical World's Digest of Current Electrical Literature, by Carl Hering ... 377
The Electric Motor for Operating Machinery ... 379
FINANCIAL INTELLIGENCE, 380; Affairs of the Companies, 381; New Incorporations, 381.
SPECIAL CORRESPONDENCE: New York Notes, 381; New England Notes, 382; Washington Notes, 382; Western Notes, 382.
NEWS OF THE WEEK: The Electric Light, 382; The Electric Railway, 382; Legal Notes, 382; Personal Notes, 383; Miscellaneous Notes, 383.
INDUSTRIAL AND TRADE NOTES ... 383
BUSINESS NOTICES ... 384
OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS ... 384

A Little Knowledge a Dangerous Thing. A MAYOR of a town in England in a recent address spoke of the civilizing effects of the advance of science, and among other things suggested that the lines of latitude and longitude should be taken up and replaced by submarine cables!

Proper Use of Terms. AN English contemporary in a supplement defines the Board of Trade unit as one thousand watts for one hour, and but a few lines above says that a unit is a thousand watts. It seems to us that this term is used in a very loose sense, although, of course, a confusion need not necessarily arise in the mind of an electrical engineer, who will understand from the context what is meant. If a "unit" is "a thousand watts for one hour" it is not suitable for measuring the quantity of electrical energy registered by an ordinary consumer's meter in which one unit may just as well have been a thousand watts for one hour as one watt for a thousand hours or any other product of hours and watts amounting to one thousand. Judging from the methods of charging used in England, namely, a fixed price per unit, both the definitions given in that paper are incorrect, as a unit is, in that case, neither a thousand watts nor a thousand watts for one hour, but it is simply a thousand watt-hours without any further qualification. One horse-power-hour may be intended to mean one horse power for one hour as distinguished from two horse power for half an hour, but from the way in which electrical energy is sold in England there appears to be no such qualification in the definition of the Board of Trade unit. Careful writers will do well to express themselves more clearly in using this term.

Earth Currents. A VERY interesting phenomenon and one that has received considerable attention from various experimenters, is that of earth currents. A variety of theories have been advanced as to the cause of these currents, careful study has been made of their nature and strength and the frequency of the intervals at which they manifest themselves, and it has even been proposed to store up their energy for commercial use. Mr. J. Kennedy Gibson has made a series of interesting experiments upon the subject on one of the Java-Australian cables, the results of which are given elsewhere in these columns. His observations differ in many respects from those made in other quarters of the globe. In all his experiments the diurnal variation seems to be fairly uniform, the times of maxima and minima agreeing in a marked manner. On the Atlantic cables it has been found that there are two complete alternations in twenty-four hours, while on the Java-Australian cable there appeared to be but one of about thirteen hours' duration, while during the remaining period the currents are weak and variable. The slope of earth-current variation does not seem to coincide with that of the tidal lines. Mr. Kennedy is not inclined to accept the hypothesis that the earth current variations are due to either the sun or the moon individually, but suggests that they are more probably due to the combined influence of the sun and the moon, and are also affected by thermometric and barometric variations.

Government Premiums. THE policy of the United States government in awarding premiums to shipbuilders for exceeding contract requirements in regard to the speed or horse power of men-of-war might, with great advantage, be extended to include the electric lighting plants of naval vessels. Such a policy would serve as a great stimulus to efforts to reduce the weight and space occupied by such plants, and as the merchant marine would directly participate in the benefit resulting, the effect would be much wider than when applied to speed or horse power alone as at present. As the electrical plant, unlike the ship and her machinery, would be designed by private firms and not by the government, and participation in the competition would not be narrowed to a few firms, there could be no suspicion that the bonus was of the nature of a gift, and the policy, therefore, would undoubtedly meet with general public approval. To put the matter on a basis for wide competition the proposal for the plant proper should not include the wiring of the ship nor the fixtures. But few firms manufacturing electrical machinery would care to undertake the latter with the uncertainties involved, and as a consequence at present there is little or no competition for goverment contracts. As there is no necessary connection between the electrical plant proper and the wiring and fixtures of a ship, there is no reason why they should be coupled together in proposals, particularly as the effect must be to practically kill competition and therefore improvement. If proposals were asked separately for the electrical machinery and a bonus offered for an excess of the contract requirements, there can be no doubt but that the government would be greatly benefited; on the other hand, if the other electrical work were not done at the navy yards, as it might be, it is only fair that it should be open also for general competition.

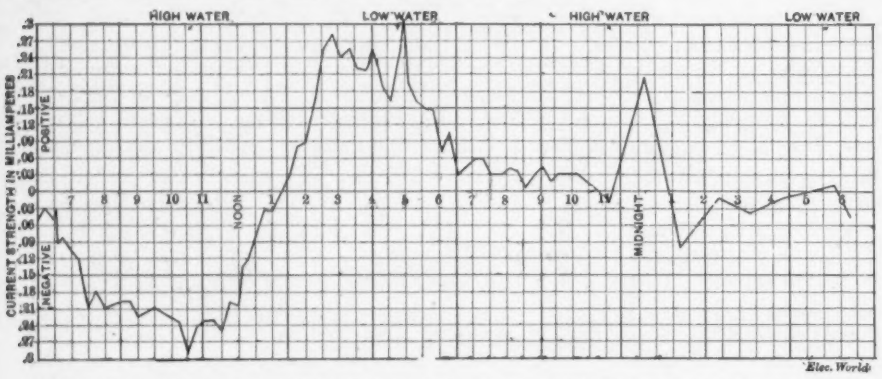
The Westinghouse Switchboards. THESE great switchboards, which control all of the incandescent lighting circuits of the World's Fair buildings in Jackson Park, are described elsewhere in this issue. It is not unlikely that this exhibit will attract more attention from the more technical visitors than any other one display at the World's Fair. One needs to take but a glance behind the boards where the connections are made to be convinced of the seemingly almost hopeless task, which our correspondent has attempted, to make clear this apparently complex arrangement of wires, and yet, upon reading his article, it will be seen that the complexities are more apparent than real, and that by tracing the connections on a single panel to the other parts of the system, the whole scheme is resolved into one of such simplicity as could alone be of service for such a purpose. While much more could have been said in regard to these boards, it is doubtful if it could have been said to advantage or without seriously involving the mind of the reader in the apparent intricacies of the structure itself. One thing more can be said, however, which involves the dynamos as well as the switchboards, and may be properly said at this point, although the description of the dynamos has no place in this article. As stated, each of the large alternators is in reality two separate machines, each with its own separate armature and connections. Each armature generates a separate single-phase alternating current, but the two armatures in each machine give currents whose phases differ from each other by 90 degrees; thus by properly connecting the circuits at the switchboards and also at the further end, making the two inside wires at the further end the common path to both circuits, the united currents may be used as a two-phase current on a three-wire system for Tesla two-phase alternating motors and is so employed to some extent for power purposes. In this great plant there are 12 of these double alternating current dynamos, each with a capacity of 15,000 50-watt lamps, and two smaller dynamos, which, together, are handled by the switchboards in the same way as the two armatures of the large machines, each of these having a capacity of 4,000 lamps. Thus we see that this single switchboard controls through the 40 feeders a lighting capacity of 188,000 incandescent lamps, which are distributed in all parts of the grounds and constitute by far the largest lighting plant ever constructed.

New Underwriters' Rules. THE uncalled-for mystery surrounding the discussion and promulgation of the fire underwriters' rules that have been under consideration since last August has finally been dispelled, and we learn that the rules were submitted some time ago to the various insurance companies and associations for adoption. The new rules are the result, with slight modifications, of the deliberations of underwriters' experts held in New York City last August and December, whose meetings also resulted in the formation of the Underwriters' International Electric Association—a body with a well defined field of usefulness before it. With some important exceptions the rules are those formulated and adopted by the National Electric Light Association, the departures being in the direction of greater stringency. Among the radical and commendable features are the prohibition, by implication, of wooden cleats and the requirement that all telegraph, telephone and similar conductors shall be provided with some protective device where they enter a building, to obviate danger from cross currents. The requirements that *all* safety fuses must be stamped or otherwise marked with the number of ampères they will carry will greatly abridge the use of fuse wire; while this is greatly to be desired for the larger sizes, it is very questionable if it should be made to apply to the smallest sizes, such as are used in ceiling rosettes and fixture cut-outs. Another prohibition, fortunately of little practical moment, is against the use of multiple-series or series-multiple lighting, which, we presume, does not apply to the use of incandescent arcs, although they are not excepted. We note that the smallest gauge of wire that can be used outside of conduit tubing and fixtures has been reduced from 16 B. & S. to 14 B. & S., and that the use of staples is absolutely prohibited. The requirement of a double-pole switch for a single light on a gas fixture will prevent the use for this purpose of a number of special switches now on the market, and those in regard to electric gas lighting will prevent the use of many of the present forms of electric burners on the same fixture with electric lights. We do not find any reference in regard to the use of flexible cord pendants in places like textile works where there may be a accumulation of highly inflammable material on the lamp cord. It is a matter of no uncommon occurrence for flexible cords to be ignited, without blowing a fuse, and while they are required by the rules to be covered by a non-inflammable layer, yet sufficient heat may be generated to render their use dangerous in the cases referred to. The cause of the accident in question is obscure, but it nevertheless exists, and one underwriters' association, at least, required under the circumstances named that the pendants should be of solid No. 18 B. & S. wire. Taken as a whole, the rules are characterized by sound common sense, and show a due appreciation of the interests of those to whom they are to be applied. Their general adoption now rests with the various insurance companies and associations interested in electrical risks, and it is most sincerely hoped that these bodies will take speedy action toward their adoption and thus remove a reproach to electrical inspection which has heretofore existed on account of the number and disparity of independent rules in existence.

Earth Currents.

BY J. KENNEDY GIBSON.

I have recently seen the report of Mr. Wm. Finn's interesting paper on "Earth Currents" in The Electrical World of Nov. 19, 1892. Since electricians are again bestowing some attention on this subject, they may, having much more data at their hands, produce a satisfactory theory of the cause or causes of earth currents, and of their variation. The hypothesis put forward by Mr. Finn does not seem to me to afford an adequate explanation. Though I cannot pretend to the experience of Mr. Finn in the observation of earth currents, yet, as the observations I have made on a restricted scale in this quarter of the world differ from all others I have seen, they may be of interest. At intervals during a period of six months I have, on one of the Java-Australian cables, taken series of observations, which I have plotted, and the last series of which are shown in the accompanying illustrations as a sample of the variation. In all the diagrams the diurnal variation presents a close uniformity of outline and a marked agreement of the times of maxima and minima. In the accompanying diagram it will be noticed that the variation of earth current is very different from that on the Atlantic cables, for, while the latter presents two complete alternations in twenty-four hours, the former has only one complete alternation, which occupies about thirteen hours; and during the remaining period, that is, during the night, the earth current is very weak and variable in direction. In the accompanying diagram the comparatively large current at midnight is exceptional. I have traced on several of my diagrams the lines connecting the times of high and low water, and, though sometimes the slope of earth current variation coincides with that of the tidal lines, yet sometimes it is exactly in opposition, and at other times the slopes occupy intermediate degrees of coincidence and opposition. Then it must not be forgotten that in my observations there is no slope of earth current variation during the night. I am disposed to receive with caution any hypothesis that seeks to find an explanation of the earth current variation in the moon or sun individually, for I think the influences acting on earth currents are very complex. As the earth current and magnetic disturbances are generally recognized as being due to solar disturbances, "sunspots," is it not likely that the normal variation is due chiefly to solar influence, to lunar effects in a minor degree, and that it is also affected by thermometric and barometric variations?



EARTH CURRENT VARIATIONS ON THE JAVA-AUSTRALIAN CABLE.

Port Darwin, South Australia.

Unjust Law.

Mr. Edward P. Thompson, in a recent communication, calls attention to an error in the article on this subject by Mr. A. B. Upham which appeared in The Electrical World of March 25, 1893. The statement was there made that "in Canada a patent may be secured for five, ten or fifteen years." Mr. Thompson states that under the new Canadian patent act of 1892 the respective terms are six, twelve and eighteen years, which is a boon to the inventor, because he can now take out a patent in Canada one year prior to the application in the United States without shortening the term of the patent in the latter country. It might be added, however, that in order to enjoy this privilege the Canadian inventor must at the outset take out his patent for the whole eighteen years, which is now rarely done, or he must renew it at the end of six and twelve years respectively; otherwise the United States patent would be affected by the shorter life of the Canadian one.

Pennock Bobs Up Again.

The Boston "Post," which should know better, recently published the following:

Several private trials recently made at the Hotel Reynolds of the Pennock primary battery electric light prove the system a great success. Last night Proprietor Reynolds congratulated Mr. Pennock on the beauty of the light. The system will be open to the public in about two weeks.

When seen last night by a "Post" reporter, Mr. Pennock was in a very happy mood, his patent for the voltage distributor having just been allowed by the Patent Office.

With this wonderful machine it is possible to produce 1,000 electric lights with the same power it takes to run one lamp. Mr. Pennock has applied for another patent, by which he claims he can produce 25,000 lights at a cost not to exceed 10 cents an hour for the entire lot. The statement would seem credible, the United States having allowed the great claims of the first patent.

The company is now erecting a plant of 150 lights at 400 Main street, Bridgeport, Conn.

The State Executioner.

Mr. G. Wilfred Pearce, of Brunswick, N. J., has the following communication in the New York "Sun" of May 9:

Many newspapers habitually refer to the man employed by the State to torture malefactors to death by electricity in Sing Sing prison as an "electrician." It is true that times are not prosperous in the electrical profession, but there is not one member who will degrade his manhood and prostitute the noble science of electrics by torturing condemned criminals to death for $3 a day and the old clothes of the prisoner. Let a name be invented to describe the business of the men who have displaced hangmen. Electricians they are not; and if they are to be called so despite the protests of the electrical fraternity, then by all means let us call by another name the science made illustrious by Franklin, Davy, Faraday, Edison and Lord Kelvin.

NEW BOOKS.

Dynamos, Alternators and Transformers. By Gisbert Kapp, M. Inst. C. E., M. Inst. E. E. London: Beggs & Co. 483 pages, 138 illustrations. Price $4.

The author states that it has been his object to place before the reader an exposition of the general principles underlying the construction of dynamo-electric apparatus, and to do this without the use of high mathematics and complicated methods of investigation. While the avoidance of mathematics altogether is impossible in a book treating of an engineering subject, the endeavor has been to restrict its use within such limits as will enable the average engineering student and average practical engineer, even if he have no previous knowledge of electrical science, to follow the subject.

The first 14 chapters deal with electrical theory and continuous current machines, the next two chapters with the theory of alternators, another with transformers, and the final chapter describes various forms of commercial alternators. The treatment is necessarily sketchy, from the limited space and wide range of subjects, and the subject of armature windings alone seems to be treated at adequate length. It is to be regretted that the so-called English system of electrical measurement has been introduced, as the mixture of "Kapp lines," centimetres, feet, grammes and pounds more than neutralizes any benefit there may be in the system, which benefit is exceedingly doubtful under the most favorable construction.

The authorship of Mr. Kapp gives the book a stamp of value that an examination confirms, and the present work is a valuable contribution to technical literature, and particularly as an introduction to electrical design.

The Theory and Practice of Absolute Measrements in Electricity and Magnetism. By Andrew Gray, M. A. Part II., in two volumes. London: Macmillan & Co. 1893. 346 + 868 pages, 198 illustrations. Price, $6.25.

After some years Prof. Gray has completed his exhaustive treatise on absolute measurements, the concluding part being in two volumes. This finally adds another work of the highest character to electrical literature, and one that will rank with the half score or so of books that will be classics.

The first volume of Part II. treats of magnetic theory, electromagnetic theory and current induction, including co-efficients of induction, induction in conductors carrying alternating currents, magneto-optic rotation, energy of the medium, etc. The second volume is devoted to the absolute measurement of the various electrical quantities, comparison of units, determination of magnetic distribution, induction and permeability, with sections on electric oscillations and radiation, and the molecular theory of magnetism.

This great work is indispensable for the laboratory and a valuable assistant to the student in the study of electrical and magnetic theory, and indeed may be considered as a complete and connected treatise in itself.

Formulaire de l'Electricien. By E. Hospitalier. Eleventh year. 1893. Paris: G. Masson. 387 pages, illustrated. Price, 5 francs.

Each succeeding edition of this admirable electrical reference book increases in value, and it is not too much to say that it is easily first among books of its kind. As in former editions, the first and second sections consist of a general statement of the principles of electrical and allied science, which is a model of lucidity and conciseness, and numerous tables containing electrical, mathematical, mechanical and general physical constants and data; the third section treats in a thorough manner of the apparatus and methods of electrical measurements, while the last and most important one is devoted entirely to the practical applications of electrical science. In this section, which is a perfect mine of practical information and data, most changes and additions have been made, notably in the chapters on transformers and accumulators and central stations; the transmission of power is fully treated, and with particular attention to multiphase transmission, in regard to which there is a very complete collection of data, probably the first that has been made.

Marine Electric Plants. Special Number of the "Electrical Plant." Edited by H. Cuthbert Hall. London: "Electrical Plant," Limited. Jan. 1, 1892. Ninety-one pages, numerous cuts and plates.

The special number of the "Electrical Plant" for this year is devoted to marine electrical plants and appliances. handsomely printed on an extra quality of paper, and tastefully bound the brochure is a very creditable production. About one-third of the pages are devoted to the plants of English and American men-of-war; following are sections on electricity in the French navy, the mercantile marine and on pleasure, torpedo and submarine boats, and the remaining sections are on search lights, electricity in lighthouses, and on the lighting of harbors and docks and several miscellaneous subjects. The illustrations are numerous, but the utility of some 10 double page half-tones of the exteriors of ships is left to conjecture.

Patentable Inventions. By Edward S. Renwick. Rochester: The Lawyers' Co-operative Publishing Company. 1893. 155 pages. Price, $2.00.

Mr. Renwick is a civil and mechanical engineer and a solicitor of patents who has been a patent expert for 43 years, and is also a successful inventor. The author is thus abundantly qualified to write on the patentability of inventions from the legal, mechanical and inventor's standpoint, and this book will consequently be found of great value by inventors. The legal questions on all the points are considered with reference to decisions and in a manner that appeals more to the mind of an inventor than the writings of professed jurists. While the book is primarily a treatise on the legal questions involved in patent law, the discussion of the various scientific and mechanical principles involved adds a value not usually found in such works.

The Mineral Industry, Its Statistics, Technology and Trade in the United States and Other Countries. Vol. I., 1892. Edited by Richard P. Rothwell, editor of the *Engineering and Mining Journal*. New York: The Scientific Publishing Company, 1893. 628 pages. Price, $2.50.

For many years the *Engineering and Mining Journal* has published annually a statistical supplement, and in the present year this takes the form of a large octavo volume, which will be continued hereafter in the same form, a volume to be published annually.

The work contains an interesting statistical article on the use and production of platinum, and information of value to the electrical industries in the sections on electrolytic copper and processes for treating zinc-lead ores, electrical reduction of aluminium, and several other allied subjects.

Pumping Machinery: A Practical Handbook Relating to the Construction and Management of Steam and Power Pumping Machines. By William M. Barr, Member of American Society of Mechanical Engineers. Philadelphia: J. B. Lippincott Co., 1893. 447 pages, 264 illustrations. Price, $5.

The central station manager and others will find much of value to them in this very complete work. The subject of feed and other pumps is exhaustively treated, and all of the various standard types in use are fully described and illustrated in detail. The subjects of piping, air chambers, etc., are also treated at length. To those who have to do with pumps or wish to study up the subject, this book will be very useful.

LITERARY NOTES.

"Electromagnetic Theory," by Dr. Oliver Heaviside, will soon be published. This will deal in a more elementary manner with the theories developed in the important "Electrical Papers" lately reviewed in these columns.

Those with nautical tendencies will be interested by a little book on "Knots, Splices, Hitches, Bends and Lashings," by Ensign F. R. Brainard, U. S. Navy, and even confirmed land-lubbers will be able to derive profit from some of its information. All imaginable ways of manipulating ropes are described and illustrated, so that any one through it may easily learn to rival a jack tar in this line. (Practical Publishing Co., N. Y. Price, $1.)

Through the kindness of Mr. F. E. Barker we have received a copy of the complete Report of the Board of Gas and Electric Light Commissioners of the State of Massachusetts, an extract from advance sheets of which appeared in The Electrical World of April 15, 1893. An unusually valuable feature of the report is the collection of balance sheets of the various central stations in the State, from which valuable data for many purposes may be obtained.

The last annual volume of the Seismological Society of Japan contains an interesting account of the great earthquake in Japan of Oct. 28, 1891, in which 9,960 people were killed, and 128,750 houses totally destroyed. Prof. Milne states that the magnetic instruments stationed at Tokyo have never yet shown any magnetic perturbations due to earthquakes, and that no conclusion has yet been reached as to any influence of earthquake phenomena on the potential of the atmosphere or in producing earth currents.

The Westinghouse Charges Against the General Electric Company.

The Westinghouse charges against the General Electric Company have received no new developments during the past week. The persons arrested in Pittsburgh waived preliminary examination on May 10, and gave bail. The Westinghouse Electric and Manufacturing Company has given the following statement to the press:

"Our counsel was on hand to-day (May 10) before Alderman McMasters with ample evidence to establish beyond question the charges against the defendants. We were not surprised that Mead, notwithstanding his protestations of innocence, did not dare to face a hearing before the committing magistrate; nor were we surprised that the other defendants, who have not yet been served with orders of arrest, by reason of their being outside of the State, failed to respond, even by counsel, notwithstanding their published boasts of innocence and of a desire and readiness to meet the charges where they were made.

"We did not take this matter up without having in our possession ample evidence of our charges, not only against the defendants who have been served with orders of arrest, but also those who are still outside the State.

"We propose to push this matter and to exhaust every lawful means to bring the conspirators to punishment. Having discovered the extensive thefts which had been perpetrated under the direction of the conspirators, and the tremendous injury it was doing to our business, we felt it our duty to ourselves, our customers and the public generally to take the course we have pursued. The statement of those connected with the General Electric Company that we were actuated by any other motive is simply absurd."

President Chas. A. Coffin, of the General Electric Company, pronounced the charges false and malicious, and intimated that their object was to affect the stock market.

E. W. Rice, Jr., general superintendent of the General Electric Company, stated, concerning the accusation of the Westinghouse company that the General Electric Company had stolen "blue prints" from them: "My knowledge of the affair has been largely gleaned from the newspapers. Referring to the visit of the Westinghouse company to the Lynn works last Thursday, I desire to state that they obtained admission to the factory and my office in a highly improper manner, by leading the attendants to think they were customers of the company, and that they wanted to see certain plans of a railroad. They said that they had been given to the company by one of the members of the party. They gained access to my desk and my private papers, but they did not find any of the Westinghouse 'blue prints.' I consider that the action of the Westinghouse company in this affair is only a part of the general policy which they have adopted to injure the General Electric Company."

On the Proposed Practical Magnetic Units—Gilbert, Weber, Oersted and Gauss.

BY A. E. KENNELLY.

A complete view of the existing situation in regard to the proposed new units can be best obtained by a brief review of the history of the present units.

Ever since the foundation of rational dynamics by Newton, work and force have been measured in units of length, mass and time. Taking advantage of the revolution of 1789, the French nation established the metre and gramme as the foundations of their proposed international system of measures. With French writers the unit velocity soon became the metre per second, the unit force that generating an acceleration of one metre per second on a gramme mass in each second, and so on. The simplicity of this metre-gramme system of dynamical units and the convenience of its decimal notation gradually won the patronage of the scientific writers among the nations of the European continent.

Up to the year 1850 all measurements in electricity and magnetism, excluding perhaps the work of Gauss, appear to have been only relative, and based on purely arbitrary standards. There were standards of resistance, such as a mile of copper wire of a certain gauge, standards of capacity such as particular sizes of Leyden jars, and standards of E. M. F., as, for example, the Daniell cell. But in 1851 Weber pointed out that since electrified bodies, as also currents and magnets, mutually attracted or repelled, with forces capable of precise measurement in dynamical units, those electrifications, current strengths, or magnetic poles, become capable of numerical quantitive expression in terms of mechanical force and, therefore, in terms of the fundamental units of length, mass, and time, by which force is defined, while the established laws of electricity and magnetism then serve to include all the other essential magnitudes of those sciences in the same list. If the forces measured were electrostatic, and the reduction to the dynamical units made through that channel, the expressions obtained for the current, resistance, E. M. F., etc., were called electrostatic absolute units; but if the measurements were electromagnetic, and the dynamical relations obtained from the laws pertaining to the galvanic circuit, then the corresponding expressions were named the electromagnetic absolute units, the term absolute standing in contradistinction to the relative units previously in vogue. The electrostatic expressions and electromagnetic expressions for the units of current or resistance, etc., instead of coinciding respectively, each to each, as they should, were found to differ by definite ratios, indicating that in the present imperfection of physical knowledge, errors existed in the dynamical reasoning that must be left to future discovery to correct.

At Lord Kelvin's suggestion a committee was appointed by the British Association for the Advancement of Science, in 1861, to determine the best standard of electrical resistance. The committee adopted Weber's proposition for a system of absolute units, but selected the centimetre as the standard of length.

The unit force in the centimetre-gramme second (C. G. S.) system is well known to be the dyne, and is approximately equal to the weight of one milligramme of matter. The unit of work or erg is performed by one dyne acting through one centimetre, so that one erg is approximately expended when a milligramme is lifted vertically one centimetre. According to this system, unit E. M. F. driving unit current in a galvanic circuit must expend one erg in one second. The actual standard of resistance that would correspond to this ideal absolute unit had to be determined. The unit itself was far too small to obtain with accuracy or convenience, but the ohm was finally produced representing a resistance one thousand million times greater than the C. G. S. unit. The reason for selecting this particular multiple rather than ten million or one hundred million, is stated to have been the close approximation thereby attained to the Siemens mercury unit, and to other arbitrary units already in existence.

Similarly, the absolute C. G. S. unit of E. M. F. was extremely small, and to avoid the continual introduction of large multiples into practical work, the volt, one hundred million times greater, was established as the practical unit, this magnitude being selected on account of the close approximation it attained to the E. M. F. of a Daniell cell. From the ohm and volt all the other practical units were obtained in direct sequence. Thus the volt in a circuit of one ohm resistance delivers one coulomb per second or one ampère, and does work at the rate of one joule per second or one watt, while a condenser of one farad capacity holds one coulomb under a difference of potential of one volt. All these practical units, ultimately based upon the electromagnetic forces of currents and magnets, find definite expression through dynamical reasoning, in terms of length, mass and time. It is now generally recognized that these dimensional expressions are incorrect, but their inaccuracy does not directly affect the main questions here considered. For example, the unit of resistance—either the ohm or its thousand millionth part the absolute unit C. G. S. unit—is at present evaluated as a length divided by a time, corresponding to the representation of a velocity, but there is evidence for believing that this view will be modified during the future progress of the science.

The effect of selecting arbitrary multiples of the C. G. S. units for the ohm and volt, while retaining the C. G. S. unit of time, or second, was equivalent to replacing the centimetre by a length of one thousand million centimetres, a quadrant arc of the theoretical earth's surface, and replacing the gramme by a mass one hundred thousand million times smaller (10^{-11} gramme). In other words, all the practical units would have been directly arrived at on Weber's electromagnetic system, if the unit international measure of length had been the earth-quadrant, not the centimetre, and the unit mass that exceedingly minute entity, one eleventh-et gramme, and the practical series may therefore be said to belong to the quadrant, eleventh-et gramme, second, system (Q. E. S.)

This is the argument for creating all new practical units upon the Q. E. S. series. There is, of course, no necessity for keeping to this procedure, so long as we retain the C. G. S. system as the fundamental scientific basis, for a practical unit is avowedly created to subserve the purposes of convenience as well as accuracy, but it is very doubtful whether the advantage of a greater convenience in the magnitude of a unit established out of harmony with the Q. E. S. system would not be more than offset by the difficulty of remembering its relationship to other practical units. For example, supposing that it should appear desirable to increase the magnitude of the volt ten times, so that 100-volt circuits of to-day would become 10-volt circuits on the new basis. The new volt through one ohm would give a current of 10 present ampères, and a new ampère would have to be created also if the objectionable numeral not suggested by the C. G. S. system were to be expunged. Similarly, the farad, coulomb, joule, and watt would all have to be altered in order to preserve the simple relationship that now exists between them, as also between their undenominated prototypes on the fundamental C. G. S. system.

Again, it has become apparent that however admirable the scheme for practically linking electricity and magnetism with dynamics may have appeared at the date of its inception, it contained latent defects that have developed during its employment, and that if the C. G. S. system could be inaugurated afresh, the fundamental force relations might be modified with advantage. If in magnetism the purely hypothetical unit-pole gave place to the more practicable unit magnetic flux, and in electricity the unit charge to the unit electric flux, the perpetual recurrence of the numerical factor 4π would be excluded from all but spherical problems, their natural domain. The change would now involve an alteration in all the unit magnitudes, both C. G. S. and Q. E. S. All existing resistances, capacities, E. M. Fs. and their standards would indeed have perfectly definite known values in terms of the new units, but would equally require numerical reduction to be brought up to date. Those who would benefit by the change would be the living calculators and their successors. All the non-calculators in the electrical world would have to disarrange their ideas temporarily and learn the values of the new units without any benefit beyond that which might accrue to the development of the science under the improved régime. Under such a balance of advantages the magnitude of the task involved by "rationalizing"* the units has been sufficient to deter as yet all serious discussion of the proposition.

Concerning the proposed magnetic practical units there are at least three divisions of dissentant opinion.

1st. Those adverse to the creation of any new practical units, on the plea of an already superabundant vocabulary.

2d. Those in favor of new magnetic units having magnitudes in accordance with the "rational" system.

3d. Those in favor of new magnetic units having magnitudes neither rational nor those proposed.

With regard to the first division of opinions it may be admitted that these practical units are not needed by most mathematicians. To them the C. G. S. units already existing, the C. G. S. line of induction, and the C. G. S. unit of M. M. F. and reluctance, all undenominated, have still a symbolic significance, that in their minds trained to the grasp of abstractions partakes of the nature of objective reality. But precisely the same argument could have been raised with respect to electric units at the date of creating the ohm and volt, and no one can deny the assistance that the volt and ohm have proved to the electrical world. The present difficulty in practically discussing or treating magnetic circuits is the notable absence of names for the units of the quantities involved. The difficulty would be in a great measure removed if the C. G. S. units had definite names, even although the transition from these to the Q. E. S. ohm, volt and ampère might be at times perplexing.

It has been well claimed by the exponents of division 3 that a practical unit of flux amounting to one hundred million C. G. S. lines is too large for convenience. To this must be answered, that in the C. G. S. system unit E. M. F. is generated in a circuit when the flux it incloses changes by unity per second. If this simplicity is to be retained in the practical system the magnitude of the volt requires that the practical unit of flux shall be one hundred millions of C. G. S. lines. The farad supplies a precisely analagous instance. The magnitude of the farad is very inconvenient for practical purposes of the present day, but it was decided at the date of its establishment to constantly employ the prefix micro in practical applications rather than depart from the Q. E. S. system.

The advantages that may be claimed by the representatives of class 2 have been well illustrated in Mr. Rosebrugh's recent communication in The Electrical World of May 13. The argument against the position of class 3 applies to this case also. There can be little doubt that a "rational" system of practical units from which the multiplier 4π is excluded would be very desirable. The irrational C. G. S. fundamental system, however, exists, and it may well be doubted whether the advantage of a rational practical system would not be more than lost by the expense of a discordance with the C. G. S. At present the C. G. S. and the existing Q. E. S. units are completely parallel, and they mutually assist the memory. Under the conditions advocated by the representatives of classes 2 and 3, there would be perpetual numerical discordance between them.

Of the four practical magnetic units proposed by the American Institute of Electrical Engineers, with the magnitudes for which the names Gilbert, Weber, Oersted and Gauss are suggested, the first three are Q. E. S. units and are therefore linked with the existing volt, ohm and ampère, in the same bond that unites the corresponding members of the C. G. S. system. The gauss is, however, a hybrid, belonging neither to the C. G. S. nor Q. E. S, and therefore calls for special attention. Logically, the magnitude of the gauss should be that prescribed by the Q. E. S. series, but this selection is confronted by a dual difficulty. Its Q. E. S. magnitude would be one weber per square quadrant, and not as proposed one weber per square centimetre. In the first place the sectional areas of dynamos and magnetic apparatus are measured internationally in square centimetres, and not in square earth quadrants, so that the tendency to express the flux density in webers per square centimetres is almost irresistible. Secondly, one weber per square quadrant is one ten thousand millionth part (10^{-10}) C. G. S. lines per square centimetre, and strong dynamo fields would have to be raised through 14 decimal places to find expression in this unit; whereas the prefix mega, the most powerful now existing, only raises through six. Under these circumstances the Q. E. S. magnitude for the gauss is hard to sustain, but any means that could conveniently reconcile it with the Q. E. S. system would effect a consummation devoutly to be wished.

* "Reprint of Electrical Papers," by Oliver Heaviside. Vol. II., p. 375.

Non-Synchronous Alternating Current Motors.—II.

BY DR. BEHN-ESCHENBURG.

In contrast to the above, in the single-phase motor the current on no load must be always considerably greater than the work of magnetization of the motor transformer on open secondary circuit.

If we analytically examine the equations (3) and (4) of the single-phase motor we shall find much more complicated formulæ. I omit lengthy intermediate developments. If we make by way of trial

$$i = T \sin (2\pi nt - \alpha) \text{ we obtain}$$

$$j_v = -TM m_1 \cos [2\pi (n + n_1) t + v - \alpha - \varphi_1] \quad (10)$$
$$= -TM m_2 \cos [2\pi (n - n_1) t + v - \alpha - \varphi_2]$$

$$\tan \varphi_1 = \frac{2\pi (n + n_1) l}{r} \quad \tan \varphi_2 = \frac{2\pi (n - n_1) l}{r}$$

$$m_1 = \frac{2\pi (n + n_1)}{2\sqrt{r^2 + [2\pi (n + n_1) l]^2}}$$

$$m_2 = \frac{2\pi (n - n_1)}{2\sqrt{r^2 + [2\pi (n - n_1) l]^2}}$$

Further, we obtain, when $2\pi n$ is made equal to p and $2\pi n_1$ is made equal to p_1,

$$T^2 = E^2 \Big/ \left\{ R + \frac{M^2 p (p - p_1) r}{2 [r^2 + (p - p_1)^2 l^2]} + \frac{M^2 p (p + p_1) r}{2 [r^2 + (p + p_1)^2 l^2]} \right\}^2$$
$$+ \left\{ p L - \frac{M^2 p (p - p_1)^2 l}{2 [r^2 + (p - p_1)^2 l^2]} - \frac{M^2 p (p + p_1)^2 l}{2 [r^2 + (p + p_1)^2 l^2]} \right\}^2$$

$$\tan \alpha = \frac{2\pi n L - 4\pi^2 M^2 n (m_1 \sin \varphi_1 + m_2 \sin \varphi_2)}{R + 4\pi^2 M^2 n (m_1 \cos \varphi_1 + m_2 \cos \varphi_2)}$$

If the motor has a synchronous motion then I does not become zero as in the polyphase motor, but instead

$$I_0 = \frac{M T_0 4\pi n}{2\sqrt{r^2 + 4\pi^2 4n^2 l^2}}$$

and approximately we have further

$$T_0^2 = E^2 \rho^4 \Big/ 4\pi^2 n^2 L^2 r^2 \left\{ 1 + \frac{4\pi^2 4n^2}{L^2 r^2} \left(L l - \frac{M^2}{2} \right)^2 + \frac{R^2 \rho^4}{(2\pi n L r)^2} \right\}$$

i. e., under the same simplifying conditions as were made in the formation of formula (8). If, furthermore $[\pi (n + n_1) l]^2$ is large compared with r^2, then

$$T_0^2 = \frac{4 E^2}{4\pi^2 n^2 L^2} \qquad (11)$$

$$\tan \alpha_0 = \frac{2\pi n L}{R}$$

that is, the current for no load is twice as great as the current for open inductor circuit or secondary turns. This formula was also experimentally confirmed. It expresses the main difference between the polyphase and single-phase motor, and shows that the method of operation of the two motors differs radically. Hence for the production of highest efficiency in the single-phase motor other principles come into play than are used in the polyphase motor. In both motors the current for no load is practically independent of the dimensions of the secondary conductor; this fact was also experimentally confirmed. If the single-phase motor is at rest, then the current of the exciting system is a maximum. We must then place $n_1 = 0$, and we have $T^2_{max} =$

$$\frac{E^2 \rho^2}{4\pi^2 n^2 L^2 r^2 \left[1 + \frac{4\pi^2 n^2}{L^2 r^2} (Ll - M^2)^2 + \frac{R^2 \rho^2}{4\pi^2 n^2 L^2 r^2} \right]}$$

or under conditions assumed above

$$T^2 = \frac{E^2 l^2}{L^2 r^2 \left(1 + \frac{R^2 l^2}{r^2 L^2} \right)} \qquad (12)$$

We can then, for the construction of an efficient motor, formulate the rule that the difference between the current on no load and the maximum current when the motor is at rest should be as large as possible; for this difference determines the power of the motor to retain nearly synchronous motion. Hence, the inductor turns should have great self-induction and small resistance.

The above formula for the single-phase motor only holds when the inductor system consists of more than one closed circuit; that is, when, as is shown by formula (10), independent currents of different phases are formed in the system, the currents depending on the angle of rotation which the individual sections take at any one instant. The secondary system then forms two rotating magnetic fields whose speed of rotation is different.

The turning moment of the pulsating exciting field on the rotating field of the inductor keeps the motor in motion. If all the turns of the inductor are however connected in series as, according to the assertions of Tesla and Thomson, and lately of Mr. Brown, should be done for the purpose of placing in circuit condensers and resistances, then the motor can no longer attain the same efficiency as with the arrangement of several independent circuits; in fact, the rationally constructed single and polyphase motor is characterized and defined by the fact that the secondary circuits are independent of each other. If we have only one circuit then the single and polyphase motor have a minimum turning moment when the speed is half that of synchronous motion. Hence of itself it could not pass beyond this speed. A construction which admits of an inductor system with a single circuit without an arrangement of collector and brushes shows ignorance of the method of operation of the induction motor.

If the single-phase motor is to be arranged so as to serve at times as a polyphase motor, then the construction must satisfy the conditions, not only of an efficient single-phase motor, but also those of a polyphase motor of great starting power, for the change of the single-phase motor into a polyphase motor is for the purpose of starting the motor on full load.

To start with, therefore, the following points are of importance:

As has already been remarked in the introduction, the motor transformer should not be in any one position less effective than in any other; otherwise points of lower potential will be formed to which points the motor is driven from the points of higher potential; these points act like a brake on the motion of the motor, and they may in starting lead to the appearance of dead points. In other words, the magnetic resistance to the lines of force of the primary and secondary systems should be the same for all positions, and iron constructions are to be avoided in which the exciting and the inductor systems have sharply defined teeth. A little reflection will also show that the number of nuts, holes, grooves—or, what is the same thing, the iron teeth which carry the windings—must not be promiscuously distributed through the exciting and inductor systems. Furthermore the arrangement of the inductor turns is to be so chosen that the induced currents of different phases are independent of each other; otherwise, for example, in the presence of masses of copper or copper rods, which are not distributed in complete definite circuits, similarly to the primary coils, over the iron of the inductor, the induced currents might affect each other. The course of the current cannot then be calculated; the currents have the character of Foucault currents in the sense of eddy currents; the secondary system of the motor transformer is uncertain, and, in general, unfavorably constructed. If the inductor system is built analogously to the exciting system and we retain the conditions of the former equations, then we have for the turning moment of the motor the following formula:

The potential of the two systems to each other in unit time is

$$P = \frac{1}{T} \int_0^T \int_0^\pi \int_0^\pi M i^v j_v \, dt \, dv_1 \, dv_2.$$

From the observations made in the derivation of formulæ (7) and (8), we must substitute

$$i_v = T \sin (2\pi nt - \alpha + v_1) \quad j_v = I \sin [2\pi (n - n_1) t + n_1 t - \alpha - \beta + v_2].$$

The turning moment is given by $\frac{dP}{d(v_1 - v_2)}$.

Hence we obtain the result:

$$D = \frac{M}{2} T I \sin \beta; \quad \sin \beta = \frac{r}{\sqrt{r^2 + [2\pi (n - n_1) l]^2}};$$

or, by the substitution of the formerly obtained approximate values of T and I, when the dispersion is negligible:

$$D = \frac{M^2 E^2 2\pi (n - n_1) r}{2 \left\{ (2\pi n L r)^2 + R^2 \left[r^2 + \left\{ 2\pi (n - n_1) l \right\}^2 \right] \right\}} \qquad (13)$$

If now we assume in general that not only $(2\pi n L)^2$ is very large compared to R^2, but also that for the normal load conditions $[2\pi (n - n_1) l]^2$ is large with respect to r^2, then for the polyphase motor two important cases may be considered. They are determined by the relation $\frac{n - n_1}{n}$, $\frac{l}{L}$, $\frac{R}{r}$, accordingly as these quotients are greater or less than one.

1. If for all value of n_1 in equation (13) the quantity $(2\pi n L r)^2$ is great compared with $R^2 [2\pi (n - n_1) l]^2$ then we have nearly

$$D = \frac{E^2 (n - n_1) l}{2\pi n^2 L r}. \qquad (14)$$

This case characterizes the efficient motor for our purpose, the starting power of which, for $n_1 = 0$, becomes a maximum.

2. Within wide limits of n_1, until the motor nearly attains synchronous motion, and $(n - n_1)$ becomes very small, let $R^2 [2\pi (n - n_1) l]^2$ be great compared with $(2\pi n L r)^2$. Then we have nearly

$$D = \frac{E^2}{2\pi (n - n_1) l} \frac{L}{R} \frac{r}{} \qquad (15)$$

that is, up to the limit of synchronism, the power or turning moment of the motor increases with increasing speed. Furthermore, in the second case, as against the first, with the same number of turns, that motor is of the greater power until synchronous motion is reached whose secondary resistance is the greater. The efficiency of the motor, when it has the most favorable number of turns, decreases on the contrary, when $n - n_1$ has become small, with increasing resistance; for then we have the conditions of Case 1; that is, the limits for the relations expressed by (15) are given by formula (14). The second case therefore characterizes a motor of remarkable synchronous qualities, the maximum turning moment being attained at a certain speed, which speed is determined by the conditions imposed. If the motor is overloaded, the speed suddenly drops from this number to zero. There may be practical cases in which such a motor, because of its synchronous properties, deserves the preference.

Formula (15) characterizes a polyphase motor of ideal qualities; it shows that the polyphase motor on a given potential possesses a turning moment, which becomes greater the lower its speed of rotation; that is, with greater loads on a constant potential the speed decreases or on a constant load the speed decreases with decreasing potential; that, furthermore, the turning moment is the smaller the greater the periodicity chosen for the system. As the normal speed of the motor is nearly the same as the periodicity, the efficiency of the motor is nearly proportional to Dn or more accurately to $\frac{E^2 l (n - n_1) n}{\pi n^2 Lr}$, therefore nearly independent of the periodicity. The starting power of the motor becomes the greater the greater the ratio between the self-induction and the resistence of the inductor system. The representation of formula (13), according to Faraday's conceptions of lines of force and magnetic resistance of the system, gives the constructor immediately a picture of the method of operation. The practical correctness of this formula I have proved by numerous experiments made with three-phase motors at the Maschinenfabrik Oerlikon. If the inductors of the motors were wound in the proper way, then the motor showed a maximum turning moment when standing still; by proper overloading the motor could be held at any speed. In the same way, by varying the potential on constant load, the speed could be varied from a normal of 1,500 turns to 100 turns per minute without stopping the motor. The relation to the periodicity was in the same way that given by expression (12).

The value of L determines, in general, as in transformers, the power of the motor or the type of the motor; it is determined from the magnetic resistance of the system W, and the total number of turns Z, from the expression: $L = \frac{Z^2 (4\pi)^2}{W}$. The effects of the resistance r of the inductor turns is particularly important inasmuch as with increasing r the current of the primary decreases; should it therefore be desirable to have a motor with small current, then an increase of r for the same starting power can be compensated by a comparatively small increase of E; in many practical cases the increase of r so decreases the current strength that the decreased drop in the conductor of the motor increases the potential of the motor, at least as much with the same primary E. M. F. as is desired for the starting power. All polyphase motors which do not possess the above-described properties are characterized by greater dependence of their efficiency upon synchronism, as this is shown in formula (15).

I wish to remark further that the calculation of the motors, according to the formula, is as simple as that of a transformer. The formula shows that the same conditions which make the single-phase motor efficient also determine the starting power of the polyphase motor; the transformation of an efficient single-phase motor into a polyphase motor for the purpose of starting can be accomplished, therefore, by simple switching over. The change is made by means of a simple commutator; by a first turn the motor is put into motion as a two-phase motor; by turning the commutator further the turns of both phases are put in series, and the motor runs on as a single-phase motor.

It has furthermore been suggested to start the single-phase motor under load by converting it while starting up into a series or shunt motor. We see here immediately that the energy which, with a given potential, can enter the motor may be very much greater than the so-called work of magnetization on open secondary system, and that when this work is large, that is when the series motor should be efficient, the single-phase motor is not so because its losses in work of magnetization are great, and, conversely, when the induction motor is a good one the series motor formed of it must be very weak. Similar considerations prevent the change in practice of the induction motor into a shunt motor.

While experimenting with such a series motor I observed that in using wide brushes, which short circuited continually at least two collector segments, the motor started when current was only sent through the exciting system, and the inductor with the brushes was not in connection with the inducing system. By reason of this observation I could by short circuiting a suitable number of sections or inductor turns by means of a single or several brushes start the motor on a large load with only a very small current. The method of operation of this new arrangement is based upon the old principle, applied among others by Elihu Thomson, by means of collector and brushes; only the circuit of those turns, in every position of the motor, are closed upon which the inducing system produces a useful turning moment, the other turns remaining without current; these cut-out turns are those which would have a turning effect opposed to the useful moment when the motor is at rest.

In my experiments I have extended and made practically useful this principle by the use of an inductor arrangement analagous to the armature of a continuous current dynamo. To regulate the current also, more or less suitable turns can be short-circuited, depending upon the conditions of speed and load; with approximately synchronous motion all the turns can then be short-circuited in some way. The motor is then converted into a single-phase motor proper of the above description; for in the condition of motion all the turns give, as has been shown above, useful turning moments in the direction of rotation and the motor in motion no longer needs any brushes. I hope shortly to be able to report further on the success of this new induction motor.

I succeeded in using another arrangement for starting the single phase motor without changing it into a motor working on a different principle, based upon the observation that a good single-phase motor starts with great speed

if a certain turning moment is given it by mechanically turning or starting it. If the turns of the primary circuit are connected like the turns of the armature of a continuous current dynamo to a commutator, which may be set up apart from the motor, and if upon this collector proper brushes are made to rotate through which the exciting current is led into the exciting system, then evidently the direction of the magnetic lines of force of the exciting system rotates with the position of the current terminals. This arrangement therefore attains the purpose in an electric manner of producing such a relative speed between the exciting and inductor systems, as will suffice for the desired turning moment. If the brushes rotate nearly synchronously, then the direction of the lines of force compared with the inductor turns also rotates synchronously. The speed of the brushes can then be so combined at will with the speed of the rotating inductor that the total relative velocity of the two systems has always approximately the value of synchronous motion at which point the turning moment becomes a maximum. By using a sufficient number of collector segments the sparking can be gotten rid of almost entirely. I have started single-phase motors on full load by an easy rotation of the brushes, and on constant load varied the speed between the limits of normal and zero speed by varying the speed of the brushes.

In very many practical cases it is no great disadvantage in the use of motors if they are loaded down only after having reached their normal speed. It is then advisable to start the motors on no load by giving the motor a little push before throwing on the current, give it a certain turning moment; a good single-phase motor comes without further starting apparatus in a few seconds into normal motion with a good deal less than the normal E. M. F., if from without a small motion is imparted to it.

If the single-phase motor is once in motion then variations of load from no load to full load change its speed by only a few per cent. On large overload the speed may drop by about 15 per cent.

I have, I believe, here given an explanation of the nature and development of those motors which may play an important rôle in the present market; this explanation rests entirely upon experimentally determined principles and in its theory and criticism has followed the purpose of separating the efficient from the possible. The efficiency of the single-phase motor is excellent; 1, by its high useful work, which is equal to that of the polyphase motor; 2, its simple, solid construction, which excludes any wear through use; 3, its entirely regular speed with the simplest attendance, which only consists in throwing on and off of the current.

Conductors and Insulators.—VI.

BY REGINALD A. FESSENDEN.

EFFECTS OF MIGRATION OF IONS—PREDETERMINATION OF CONDUCTIVITY OF SOLUTIONS.

In the last chapter we saw that the conductivity of a solution depended upon the sum of the velocities of its ions.

Since, therefore, we have solutions of different conductivities, the ions must move at different rates. This difference in migration produces other phenomena. For instance, in Fig. 16, let A and B represent the anode and cathode, respectively, in a solution of hydrochloride acid. Let the black circles represent ions of hydrogen, and the white ones ions of chlorine.

From calculation (as will be shown below) we know that the ratio of the velocities of hydrogen and chlorine, in the state of ions, is 285.8 : 59.7; say as 5 is to 1, for the sake of convenience in drawing the figure. Suppose the ions to be placed as in Fig. 16. Here there are 14 ions each of chlorine and hydrogen. These are shown irregularly spaced and disassociated one from the other, as they would actually be seen, if that were possible. Half way between the two electrodes A and B a porous partition C is placed; as, for instance, a plate of unglazed earthenware, porous enough to let the solution penetrate through it readily, yet having its pores sufficiently fine to prevent any very rapid diffusion. In 1 it will be noticed that there are the same number of each kind of ion on each side of C.

Suppose, now, a current is passed through the solution. The hydrogen ions, in consequence of the fact that they are charged positively, and that there is a slope of potential in the solution between the electrodes, will begin to move toward B. For a similar reason, the chlorine atoms will begin to move toward A. But, while the hydrogen atoms are moving a length 5, the chlorine atoms are moving a length of only 1.

So when a quantity of electricity equal to the charge on a hydrogen or chlorine ion has passed, one ion of each kind is set free, and the ions have now the position shown in 2.

If the process is repeated, and the other unit of electricity passes, the situation is shown in 3. In 4, 5 and 6 are shown further stages.

In 6 it will be noticed that 5 ions of each kind have been set free, but that there are more ions of H and C on the side of the cell next B than on the side next A. As the quantity of water on both sides is the same, this means that the solution is now stronger on the B side than on the A side. This gives us our first way of calculating the relative velocities of the ions.

For, on looking at Fig. 16, 6, it will be noticed that the side B has gained 5 hydrogen ions, while the side A has only gained 1 chlorine atom, and that the ratio of the gains must be equal to the ratio of the velocities of the ions. So that, were we ignorant of the ratio of the velocities of H and Cl ions, we might find it out by testing the strength of the solution on the two sides of the porous plate, and measuring the quantities of the ions given off.

To take an example: If the original solution contained 109.5 grammes of HCl gas, and had a volume of one litre, since the weights of H and Cl atoms are in the ratio 1 : 35.5, there would be 3 gms. of H ions and 105.5 gms. of Cl ions in the solution, and half of this, or 1.5 H, and 53.25 Cl, on each side of C. Suppose the current passed till 1 gm. H. and 35.5 Cl were given off, the current stopped, and the strength of the solution on each side of the plate measured: we should find on the side next B

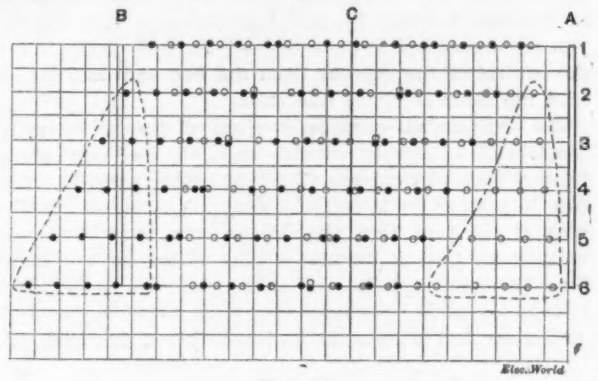


FIG. 16.

that there were 48.66 gms. of HCl in the solution, and on the side next A only 24.33.

The 48.66 gms. of HCl next B are made up of 1⅓ gms. H and 47.33 gms. Cl. One gm. H has been given off; so the total amount of H on that side of the partition is 2⅓ gms. There were 1½ gms. there originally, (see above); so that the gain is 5-6 gm.

The 24⅓ gms. of HCl on the side next A are made up of ⅔ gm. of H, and 23⅔ gms. of Cl; 35.5 gms. of Cl have been given off, so that the total weight of Cl atoms on the side A is 35.5 + 23.66 = 59.16 gms. There were 53.25 there originally, so the total gain is 5.91 gms.

As the weight of H atoms is only 1 : 35.5 that of Cl atoms, we must divide the weight of the gain of H atoms in B by 1, and the weight of the gain atoms in A by 35.5, to get the relative gain in number of atoms.

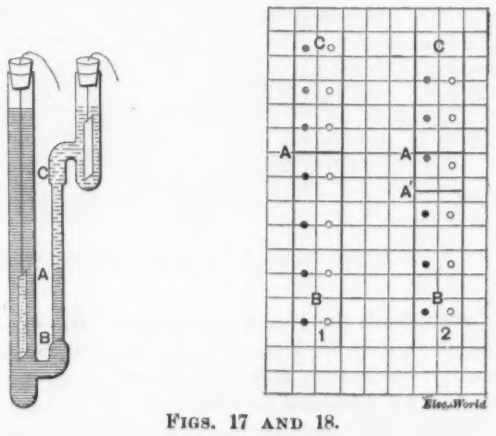
This gives $$\frac{5}{6} \div 1 : \frac{5.91}{35.5} = 5 : 1.$$

Or, the gain number of atoms by the side B is five times that of the side A. And from Fig. 16 we see that this means that the H atoms move five times as quickly through the solution as the Cl do. A more accurate experiment would have given us the ratio as 285.8 : 59.7.

In this way we can obtain the ratios of all ions.

This explanation was first given by Hittorf.

Another method is that used by Dr. Oliver Lodge. An indicator is used which is decolorized by the ion whose progress we wish to watch. In his experiment on hydrogen ions, Lodge used a jelly to keep connection currents from affecting the results, but a simpler method is to use a somewhat contracted tube. In some recent experiments made at the Cavendish Laboratory by Mr. W. C. D. Wetham, Fig. 17 gives a representation of the apparatus used. As will be seen, this consists of a glass tube in which are placed two solutions of slightly different specific gravities, and of different colors. Two such solu-



FIGS. 17 AND 18.

tions are copper and ammonium chlorides dissolved in aqueous ammonia; the former solution is blue, the latter colorless. Suppose B to represent the former, and C the latter, A being the junction of the two: what happens when a current passes from C to B may be seen from considering Fig. 18, supposed to represent a much magnified section of the tube at A. In 1, Fig. 18, let the blackened circles represent copper ions, the white chlorine ions, and the crossed circles ammonium ions. A represents the boundary between the two solutions. On a difference of potential being made between C and B, so that B is at a higher potential than C, the copper ion, having a positive charge, is propelled toward C at a rate proportional to the slope of potential at that point. Similarly, the chlorine ions will be propelled in the opposite direction.

If the velocity of the copper atoms is 8, and that of the chlorine is 2, Fig. 18, 2, represents the state of affairs when one ion of copper has been electroplated. It will be seen that the boundary has now moved to A', and that A' is nearly eight units of length distant from A, i. e., the boundary moves at nearly the same ratio as the ion of copper.

The reason why the boundary does not move at the exact rate at which the copper ions do, is that the velocity of the ammonium ions has something to do with the movement of the boundary. This is easily seen, for, if the Am ions have a much smaller velocity of migration than the Cu, then what I have called elsewhere the "volume" force will become much less in the neighborhood of the boundary, and the migration of the Cu ions impeded. If we reverse the current, the same result obtains, i. e., the copper ions are slowed up, for the volume force becomes greater at the boundary, and tends to hold the copper ions back.

It is easily seen that this effect may be got rid of by making the solution of ammonium chloride have more ions per unit volume than the solution of the CuCl has. When the number of free ions per unit volume of the AmCl solution is to the number per unit volume of the CuCl solution as the velocity of migration of the copper ions is to that of the ammonium ions, the boundary will travel at the same rate as the copper ions do. When the number of ions in the AmCl solution exceeds this, the velocity of the boundary will, on account of difference of surface tension and other reasons, be greater than that of the copper ions if the current is passed in one direction, and less if passed in the other. The mean will give the correct reading.

In the actual case considered, as the solution of AmCl. fulfilled this condition (for if both solutions were of the same specific gravity it may be easily calculated that the AmCl contained more ions per unit volume than the CuCl), the boundary, as shown by the junction between the blue and colorless solutions, travelled 1.57 cm. per hour going upward, and 1.60 cm. going downward. From this, knowing by measurement or calculation the slope of potential at the junction, we can get the specific ionic velocity, as defined above.

From the experiment, this was found to be .000309 cm. per sec.

The value calculated from the conductivity is .000310 cm. per sec.

The following table contains the specific ionic velocities of a number of ions.

Ion.	Velocity	Ion.	Velocity
Hydrogen	10.8	Copper	1.116
Hydroxyl (HO)	5.83	Silver	1.66
Chlorine	1.91	Potassium	2.05
Cr_2O_7	1.7	Sodium	1.26
NO_3	1.74	Lithium	.94

This table may be used to calculate relative resistances. For instance, suppose it were required to know what strength of solution of HCl would have the same resistance as a 1% solution of caustic potash.

In a 1% solution of KOH there are about 10 gms. of KOH. As the molecular weight of KOH is 39 + 16 + 1 = 56, this would equal 10 ÷ 56 = .178 molecule gms.

The sum of the velocities of its ions is, from the table, 5.83 + 2.05 = 7.88. The sum of the velocities of the ions of HCl is 10.8 + 1.91 = 12.71.

Therefore, the ratio of the resistances of solution of KOH to one of HCl, when both contain the same number of ions, is 7.88 : 12.71. Therefore, if they are to have the same resistance, the number of ions must be in the ratio 12.71 : 7.88.

As there are .178 molecule gm. in the 1% solution of KOH, there must be (.178 + 7.88) ÷ 12.71 = .1103 molecule gm. in the HCl solution of the same conductivity. As the molecular wt. of HCl is 36.5, .1103 molecule gm. are equal to .1103 × 36.5 = 4.026 gms. of HCl per litre.

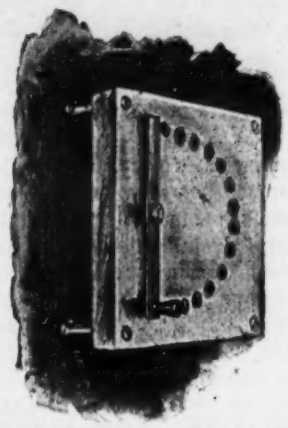
To check this result with the result of actual experiment, we find by looking up the table of Kohlrausch's results, given by Mascart and Joubert, that the specific resistance of a 5% solution of KOH is 5.86, and that of a 5% solution of HCl is 2.56. As, for dilute solutions, the conductivity is nearly directly proportional to the concentration, we find the strength of solution of HCl to be of equal conductivity to a 1% solution of KOH, to equal 2.56 ÷ 5.86 + 1 = .43% = 4.3 gms, per litre, or nearly the same as calculated above. It should be stated that 4.026 is probably nearer the true result than 4.3.

The reason of this is that, unless the solution is very dilute, the conductivity is not directly proportional to concentration. The reason for this, and the methods of making more exact calculations, we will leave to the next section.

Municipal Electric Plants.

A committee of city officials of Youngstown, O., recently investigated the subject of municipal ownership of street lighting plants, and found that there are at least 120 cities in the United States that own their own plants, or about 6 per cent. of the entire number using the arc light. In five cases named the profit derived from the sale of light for commercial purposes was sufficient to pay all expenses connected with the street lights, and in all cases the committee concluded that municipal ownership was profitable.

The Great Switchboard of the Westinghouse Exhibit.



DURING the past few weeks, perhaps the great lighting exhibit of the Westinghouse Electric and Manufacturing Company at the World's Fair has been the subject of more articles in the electrical press than any other one exhibit. This is not without reason, for the twelve huge alternators and the other two—small only by comparison—form an exhibit literally more far-reaching in their scope than any other in the whole of Jackson Park. When one appreciates that those twinkling lamps at the extreme corners of the spacious grounds owe their existence—their life, primarily, to the Indiana oil fields—thence to the steam boilers and engines of the Palace of Mechanic Arts and more immediately to the huge twin dynamos which form such a prominent feature of the Machinery Hall he can scarcely believe his senses, and in the words which first winged their flight on electrical wings, may well exclaim, "What hath God wrought?"

When Gaulard and Gibbs less than ten years ago came before the United States Patent Office with a system of distribution that was new, in that it involved a device by which currents of high potential and small quantity could be transformed into equivalent currents of small potential and large quantity, and had their patent rejected because of the impracticability or rather impossibility of such a conversion, they had solved the great problem of electrical distribution to great distances and over great areas, and although many details remained to be worked out, this then new principle had been discovered upon which such marvelous structures have since been built. To-day this great lighting plant of the Westinghouse company, founded upon this very principle, stands a monument to the energy of many minds and hands who have labored through these many years on a "fallacy," as it was decided by the astute examiners. Surely the stone which was rejected has become the head of the corner.

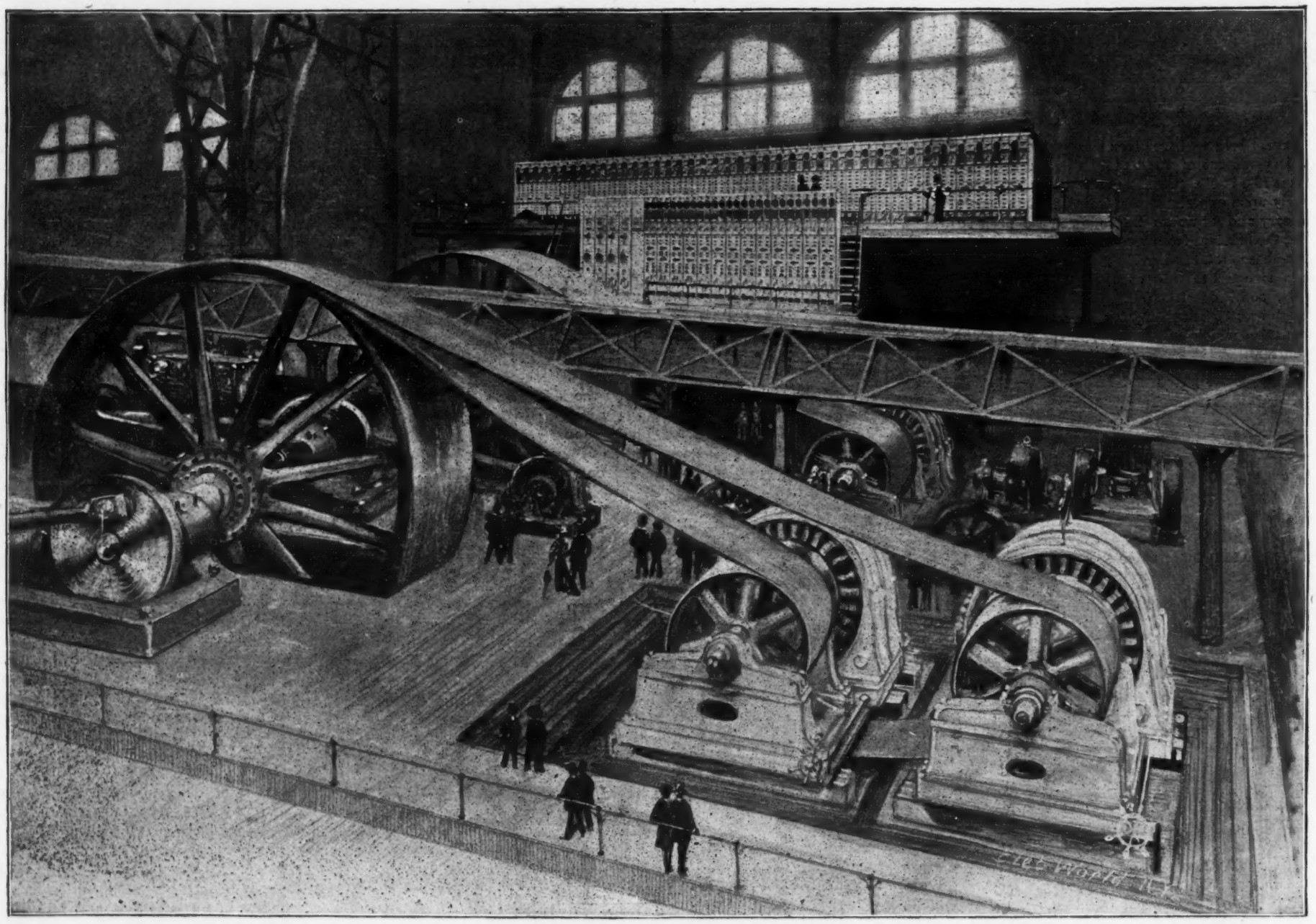
But perhaps the most interesting feature of this great exhibit to a technical man is the switchboards from which this great plant is controlled. As before stated in The Electrical World, and as shown in a large engraving accompanying this article, these are placed in galleries located at the centre of the south wall of the Palace of Mechanic Arts. In the lower gallery is placed the dynamo switchboard, which is 12 feet high and 40 feet in length, and on the upper gallery is located the great feeder board which stands 9 feet 6 inches high from the floor and is 71 feet long. The dynamo switchboard is divided into two parts entirely independent of each other. That on the left is known as the exciter switchboard, and from this are controlled the currents from the three 100-h. p. direct connected Westinghouse railway generators which excite the fields of the great alternators. In this there are five panels. Each of the three left hand ones separately controls one of the 250-volt exciting machines, and the fourth is intended for the control of an additional machine of the same character should it at any time become necessary. It is not, however, erected at the present time, and this fourth panel is therefore not now in use. The three exciting generators are connected in parallel, and the fifth panel is for the control of the current from the bus bars into which feed the three separate machines.

The large switchboard to the right of the exciter board consists of 13 panels, one for each of the two armatures of each of the large machines. Each panel is therefore in a sense double and is equipped as follows, beginning at the top: Two pilot lamps, two converters, two voltmeters, two ammeters, a plug board having in its face two spring jacks for each armature, a dynamo switch for each armature, two plug switches for each armature and a rheostat and fuse block for each. As will be seen, both the feeder board and the dynamo board treat each of the large alternate current machines as though it were two, and for this reason is each of the instruments duplicated. Most of the instruments would suggest their uses by their name, but it may be well to briefly state the office of the others at the outset in order to avoid any possible confusion.

The currents used in this plant are of 2,000 volts potential, but it is more convenient to have the volt meter wound for a less potential, and for this reason it is placed in the secondary of a transformer whose primary is in a circuit across the two main wires. The reduction in this transformer or converter is to 1-20, and therefore the voltmeter will read 100 volts when the primary circuit is at 2,000 volts. The pilot lamp is also placed in this transformer circuit.

The two dynamo switches are for the purpose of connecting the bus bars or wires, which will be further described, with the armatures; and the plug switch is to throw the exciting current from the exciter machine into the field magnets of the generator. Each of these panels is numbered to correspond with the machine which it controls. The feeder board is primarily divided into two equal parts, and these again into 20 panels each, four of which are represented in Fig. 6. Beginning at the top, each panel has the following instruments: A pilot lamp, a converter, a compensator, a voltmeter, four plug panels, a changing switch, four more plug panels, a Stilwell regulator and two fuse blocks. These panels are arranged differently from those on the board below. On this board each vertical panel is devoted exclusively to one of the armatures, and since there are two armatures in each of the large machines they go in pairs and are called the A and B panels—the two armatures of each machine being designated by A and B. The plug panels, which are the rows of plug holes running horizontally arranged throughout the length of the entire board, are numbered as shown in Fig. 6, those in the right hand half of the board being numbered from the bottom upward to 6 and those to the left of the centre from bottom upward, from 7 to 13. The row numbered 13 extends through both halves of the board, and therefore number 13 also appears on the right hand half as well as on the left hand. The top row of plug holes marks the line of the relay, which is a bus bar extending the full length of the board by which the two sides may be connected with each other from any portion of the board.

It will be noticed that each of the two large boards is numbered from 1 to 13. There are, however, but 12 of the large double generators, but there are two other smaller generators of 4,000 lights each. These two, although entirely separate and distinct from the 12, and driven by separate engines, are brought to the boards in exactly similar manner to the two armatures of the 12 and together constitute No. 13.

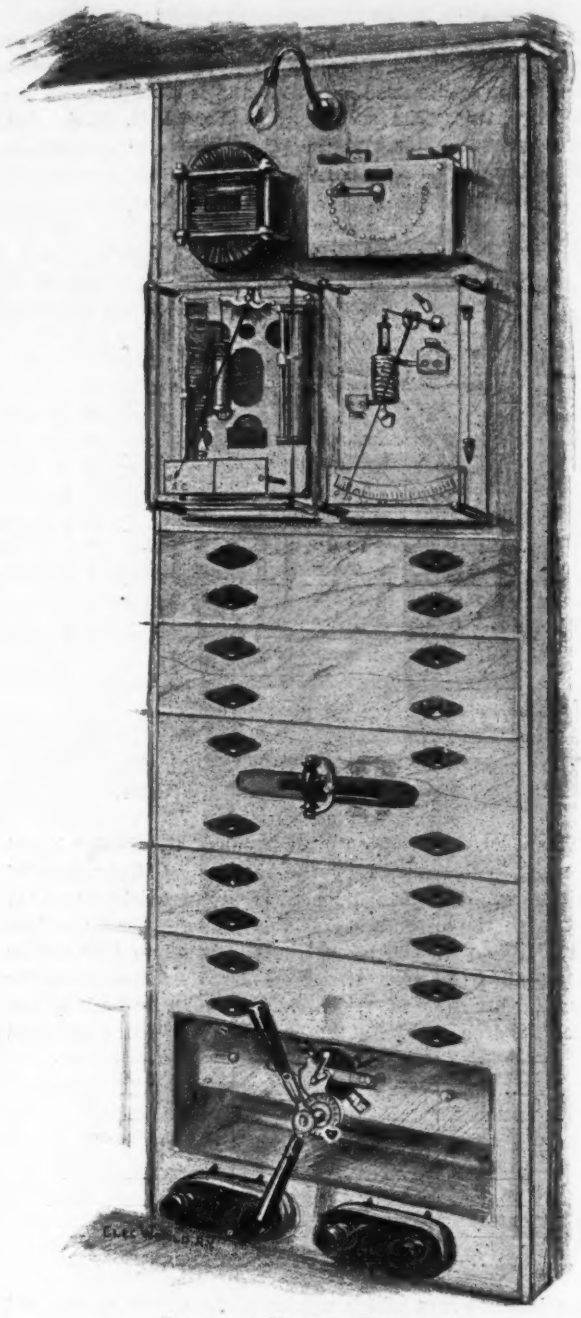


THE WESTINGHOUSE DYNAMOS AND SWITCHBOARDS.

Both switchboards are made of polished white marble, and nothing appears on the face of either of them except the indicating instruments and the handles of the switches, with the various plugs and cords required in making the necessary manipulations. All the wires are back of the panels, and everything is as nearly fireproof as possible. The instruments themselves are all covered with handsome frameless plate glass cases, which, together with the polished brass and the hard rubber trimmings, give to these boards a most attractive appearance.

The lower gallery is reached by a single iron spiral stairway in the centre, and the upper gallery, which is 14 feet in width and 83 feet in length, is reached by two narrow stairways from the lower gallery, one at each end of the dynamo board. Both of these galleries will be

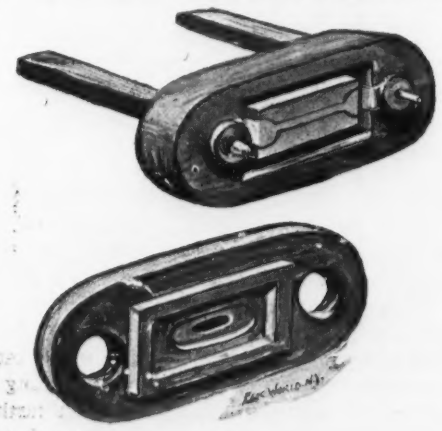
surrounded by a low ornamental iron railing about 2 feet high, similar to that of the spiral stairway by which the lower one is reached.



PANEL OF FEEDER BOARD.

To the average visitor this enormous switchboard, by far the largest in the world, must appeal as a work of art, for such it is to a superficial eye. To the electrician, however, it has a far greater significance; as to him it will appeal both as a work of art and as an example of engineering skill of the very highest order.

While the building of a new dynamo larger than any of its predecessors is still a matter of interest, the factors involved are now so well known that the demand only need be made for a larger generator to meet response from any of our well known manufacturers. There are probably half a dozen manufacturers to-day who would not hesitate to fill an order to construct a machine ten times larger than any that have been already constructed, should that order come from responsible parties, nor would it be considered in itself a feat of engineering to multiply the number of such units to any desired extent; but when it comes to the switchboards for a plant of an unusual number of units, be they great or small, the engineering difficulties are increased in more than an arithmetical ratio. The problem is not by any means solved by the addition of switchboard panels. Important as it is, that the attendant may have under his immediate control the several units of his small plant, it becomes of vastly more importance that he have equal facility of control of each individual unit of his larger plant, and the difficulty of attaining this increases, by far, more rapidly than the number of his units. While the connections



FUSE.

to each one remain the same, and are in themselves not complicated by the addition of units, it will readily be seen that in a plant of the size under discussion great difficulty would ensue if the operator were required to run from one end to the other of the board, and here and there, in order to control a circuit which happened to require at that moment his attention. In this enormous switchboard on the upper gallery, the terminals of 40 feeders are brought to the instrument. There are at present 4 panels in the exciter board, and 13 additional

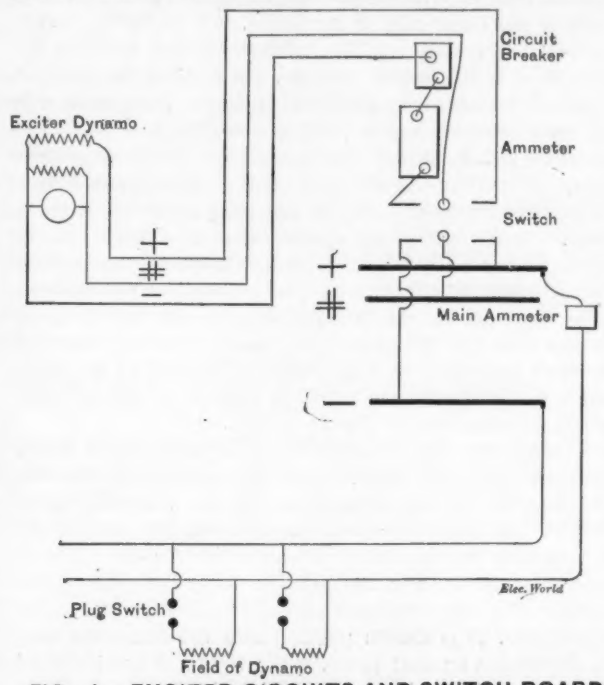


FIG. 1.—EXCITER CIRCUITS AND SWITCH BOARD.

ones in the dynamo board proper, any one of which may require the attention of the operator at any moment, and, as before stated, the highest engineering skill was required to so arrange the circuits and connections.

While most visitors interested in electricity understand in a general way the simple character of the central station or dynamo switchboard, they would probably be appalled at the apparent complexity of the connections which a view behind these boards would reveal to their eyes. It would seem to them a hopeless task to trace out this maze of wires, and they would be filled with astonishment to learn that both of these switchboards can be fully attended to by two competent assistants, and that when operations commence and readings are taken from the instruments at intervals of from 15 to 20 minutes, but one additional operator will be required; but it is only when the boards are taken as a whole that they seem complex, and if we will examine them panel by panel, and perhaps with the aid of the diagrams we will be able to unravel this apparent tangle of wires and get a glimpse of the plan of this magnificent piece of engineering work.

THE EXCITER BOARD.

Let us commence with the exciter board. By refer-

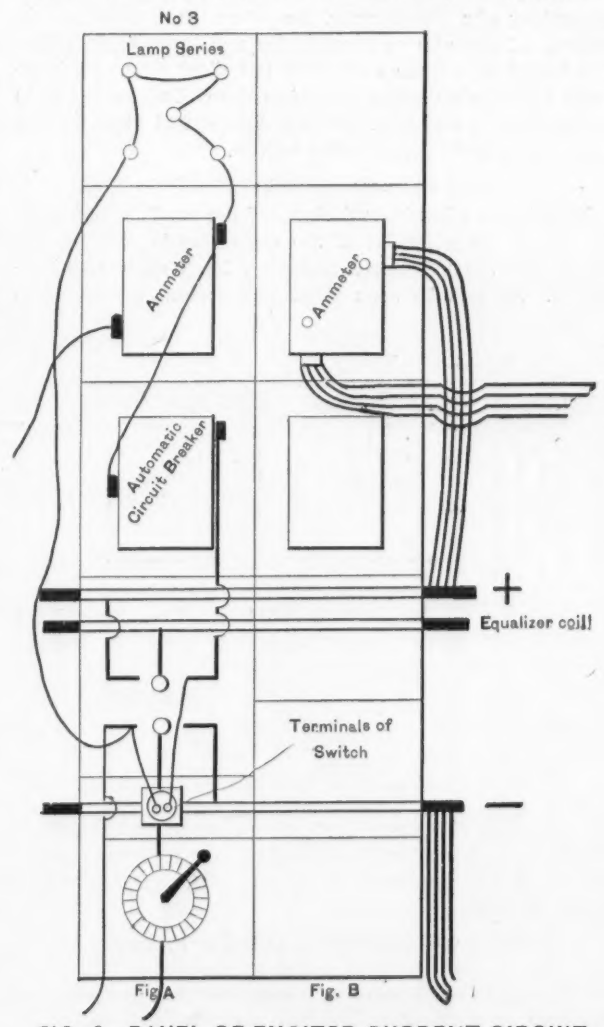


FIG. 2.—PANEL OF EXCITER CURRENT CIRCUIT.

ence to Fig. 1, we see in diagram the arrangement of the circuits which are here controlled on a single panel. As before stated, each panel on this board controls one of the exciter dynamos. The latter are compound wound, and the positive wires come from the series coils and are connected thence with one side of the double-pole dynamo switches. The central wire of the three, which is marked with the double plus sign, is designated as the equalizer circuit. This is connected to the centre of the switch and the negative side after passing through the automatic circuit breaker, and the ammeter is connected with the dynamo switch just opposite the terminal of the positive wire, thus the three terminals of the three circuits end

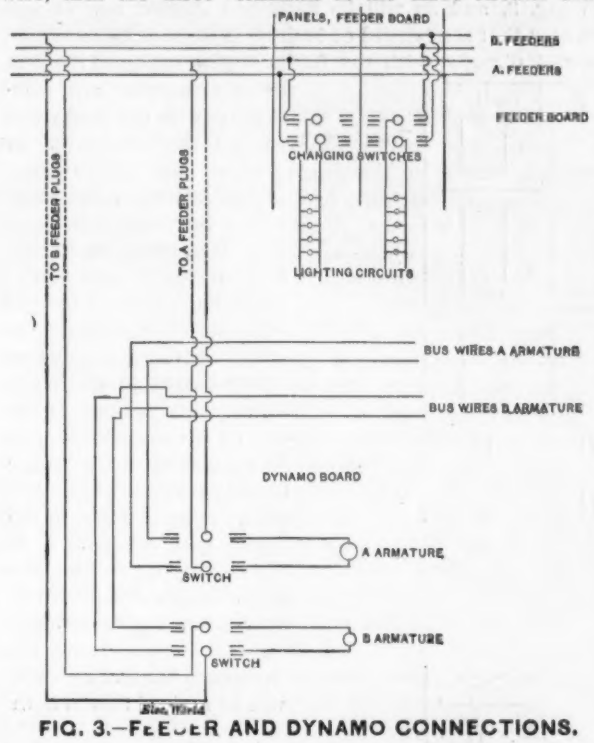


FIG. 3.—FEEDER AND DYNAMO CONNECTIONS.

in the above described portions of the dynamo switch. Back of the board are found three bus wires, corresponding to the three circuits already described, to which these circuits are connected from the three exciter dynamos in parallel to the fifth panel where their united circuits go to their appropriate instruments when it is desired to throw them all in action in multiple. It is, however, necessary that each separate exciter be under independent control; therefore, the connections are continued, as shown in the diagram, so that each field for whose excitation these currents are intended may be separately connected to any one of the exciter dynamos by the mere manipulation of the proper plug switch found on the larger board to the right. At the top of the exciter board, except in the right-hand panel of the five, are found groups of five lamps. These are 50-volt lamps, placed in series and connected across from positive to negative. In Fig. 2 an attempt has been made to show the face of one of these individual exciter generator panels, together with the extreme right-hand one, which handles the currents of the other three when thrown in multiple. The wiring connection on the back of the board has also been shown diagramatically. The only connection which this board has with the larger dynamo board to the right is that through the plug switch indicated in Fig. 1, by which the exciter dynamo current is thrown on or off the desired field magnets.

THE DYNAMO BOARD.

As before stated, this portion of the board is divided into thirteen panels, each of which contains duplicate sets of instruments, one for each armature of the thir-

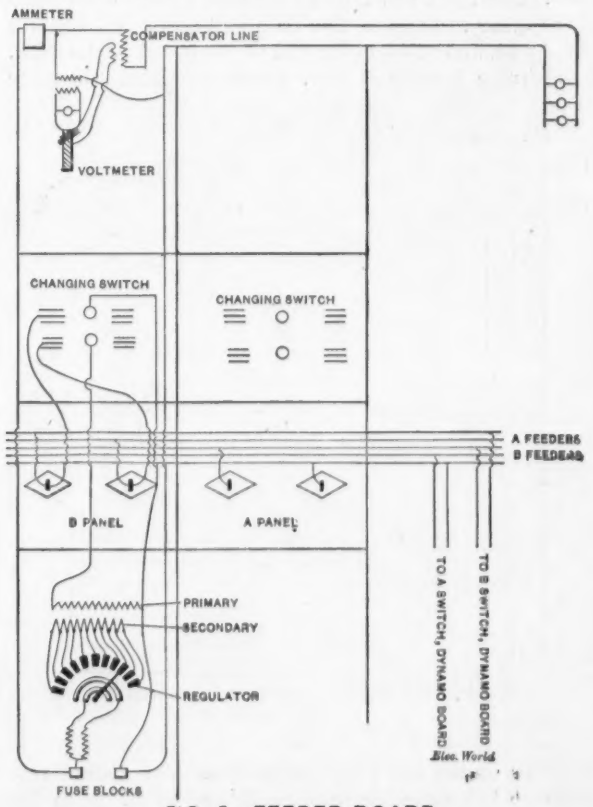


FIG. 5.—FEEDER BOARD.

teen composite machines. The uses of these instruments need not be further referred to here. We have seen in Figs. 1 and 2 how the exciter circuits are connected and controlled. In Fig. 3, we will endeavor to trace the courses of the alternator circuits from both armatures of a single composite. Both sides of each armature are connected to the same side of the two switches. The

opposite sides of these two switches are connected each to two bus wires which run the full length of this board and are labeled to designate the armature to which they belong. The centres of these two switches are connected by wires with the feeder board, and are thence connected to the desired lighting circuits as diagrammatically shown in Fig. 3, and as will be described further on. It will be seen that the centres of both of these switches are connected directly with the feeder board, whereas the left hand terminals are connected with the bus wires of the dynamo-board. In Fig. 4, we find a plug panel having four plugs which correspond to these four bus wires, which are also reached by similar plugs on each of the 13 panels. By plugging from either of the terminals of either switch to these bus wires, any armature of any of the composites may be connected to the feeder board by means of the bus wire. A little study of the lower part of Fig. 1 b, which represents the dynamo board, will make it clear how these permutations are possible. By reference to Fig. 4 again, it will be noticed that in both switches the terminals to the left are blank; this is true of the face, for no plugging is required on that side of the switch, for, when the latter is thrown to the left, the dynamo is cut out of circuit.

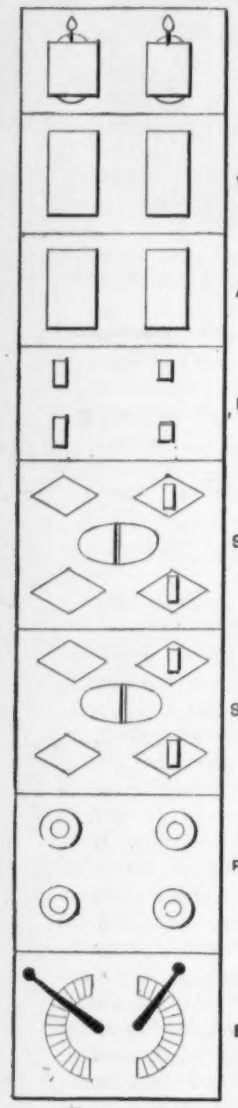


FIG. 4.—DYNAMO BOARD PANEL.

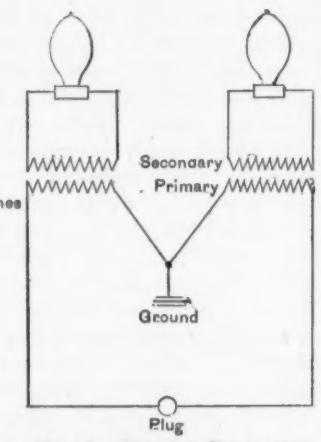


FIG. 8.—GROUND DETECTOR, FEEDER BOARD.

THE FEEDER BOARD.

A preliminary description of this board has already been given. It remains now to describe more specifically its different parts. As before stated, it is divided into two equal parts, and the plugs are arranged in horizontal rows, numbered, as shown in Fig. 6. From the dividing line in the centre, the first two plugs in the lowest line represent the terminals of the A armature of composite No. 1. The third and fourth represent the two terminals of the other armature. The fifth and sixth and seventh and eighth, and so on to the end of the board to the right, in the same horizontal row, would represent the same terminals of the same two armatures. The second row would do the same for dynamo B, and so on up to the sixth row on the right hand side of the division. The lowest horizontal row to the left of the centre represents in multiplicate the A and B armatures of alternator No. 7, and so on up to the thirteenth row, which, as stated in the early part of this article, extends along the full length of the board on both sides. This irregularity happens only because of there being an odd number of composites, instead of an even number. Had there been 14 composites instead of 13, this row would be divided also, as are the others. The top row of plugs also extends the full length of the board on both sides, and is called the relay. The use of this is to bring any alternator, whose terminal plugs appear on either side of the board, in connection with any other circuit whose terminals appear at an inconvenient distance, either on that side or the other side of the board. It, therefore, serves merely as a connecting link and convenience between the two sides of the board. For No. 1 A or B at the extreme right of the board, by plugging up to the relay line, may as readily be connected with nine or ten A or B on the extreme left, as though the two were in adjoining panels. It is clear that the division of the board into halves is merely a convenience, for the plug rows commencing with 7 and running up to 13 might be placed equally well, as far as electrical considerations are concerned, directly above row 6, and thus the board would comprise but 20 panels instead of 40. It would make it too high for convenient handling, however, and this division has therefore been made so as to bring the highest row of plugs within reaching distance of the operator while standing on the floor.

Behind each row of plugs on either side of the board are arranged four wires, which are connected with the holes as shown diagrammatically in Fig. 7 a and also in Fig. 3. In the latter diagram (Fig. 3), the method by which these feeder wires are connected with the dynamo-board is shown, and the method of connecting in the various lighting circuits is also there shown. In Fig. 6, armature 7 B is shown plugged into the left hand side of the switch on that panel, while the right hand side of the same switch is shown plugged into 13 B. If the changing switch had previously been thrown to the left, then armature 7 B would be inserted. If, however, it were desired to throw that same circuit onto feeder 13 B, the connection would be made as shown, and the changing switch thrown to the rigrt, which would cut out 7 b and throw in B armature of the thirteenth machine. The change is made so rapidly as to scarcely cause a wink in the lamps.

A point not heretofore mentioned in all these switchboards, is that the plugs are so arranged as to make it impossible to so connect them by the flexible connections as to short-circuit a machine. This is accomplished by making the holes of the positive and negative connections of different sizes, and also the plugs which fit into them of such a size and shape that they will only fit into the appropriate holes.

THE INSTRUMENTS.

We will now take a closer look at the instruments themselves. First of all is the ground detector, which may be thrown into operation for either side of the board, by pressing one or the other of two push buttons. The rationale of this will be clear from the diagram Fig. 8. As will be seen, there are two lamps, each placed in the secondary of a transformer, the primaries of which are in series. If there be no ground, the resistance is such that the lamps will come to a dark red glow only. If, however, there be a ground, the primaries will no longer be in series, but in multiple, and the lamps will glow to full candle power on pressing the button.

THE SWITCHBOARD TRANSFORMER.

By this term has been designated the small transformer by which the potential of the main line is transformed down for the voltmeter and pilot lamp of the switchboard. As will be seen there are several transformers on each panel, but this is the only one that is visible on the face of the board.

The voltmeter might, of course, be attached directly to the circuit, but this would involve in a circuit of 2,000 volts, such as is used here, the employment of such high resistances as to be expensive and troublesome. Besides, it is desirable that each feeder circuit should have a pilot lamp, and for this purpose sufficient current must be transformed down to 100 volts to supply this lamp, and it is in this transformed circuit that the voltmeter is placed.

On account of the small amount of current required by the lamp and voltmeter, the transformer is quite small, but on account of the required delicacy of the voltmeter the wires in the coils are given generous proportions in order to reduce to a negligible figure the C^2R losses. The primary wire used is No. 22, and is placed across the feeder circuit. The secondary is No. 14 B. & S., and both the voltmeter and the pilot lamp are placed in parallel with this secondary coil.

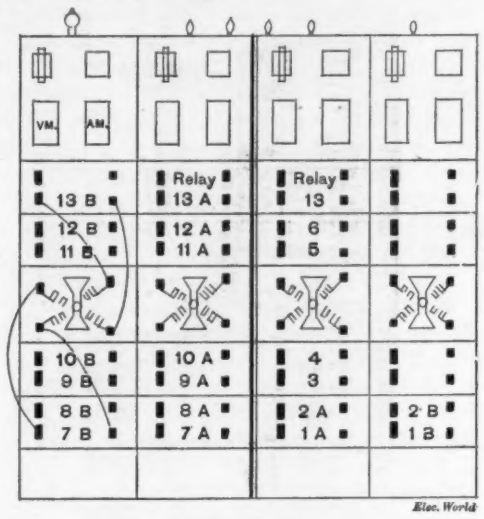


FIG. 6.—FEEDER BOARD.

The transformer is of the regular Westinghouse switchboard type known as the voltmeter converter.

THE VOLTMETER.

The voltmeter used on each panel of the feeder board is what is designated by the makers as the "type E" voltmeter. It is not connected to the main circuit at all, but with the secondary of the transformer as before stated, the potential of which is reduced to 1-20 of the potential of the line. It depends for its action upon the magnetizing force of a solenoid's tendency to suck within itself its iron core. In the centre is a pointer attached to a balance arm which carries an iron core at one end and a counterbalance at the other. This core is surrounded by the solenoid around which the current flows. In series with the coil is a fixed resistance consisting of several flat coils of German silver wire, as well as a variable resistance which, by means of a slider, may be so adjusted as to indicate any voltage within its range. In the cut the main solenoid above referred to is seen to the left, the index in the middle, while the counterweight is to the right; the variable resistance and sliding contact are on the extreme right, and the fixed resistance is behind all. The plumb bob on the extreme left is for leveling the instrument. The small auxiliary coil at the top of the main solenoid, shown more clearly in the diagram, will be explained in detail in the description of the compensator.

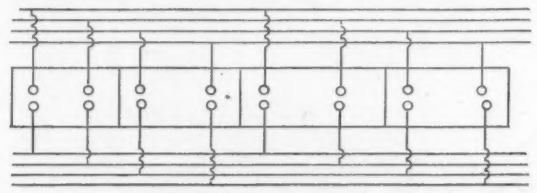


FIG. 7.—WIRING OF PLUGS IN FEEDER BOARD.

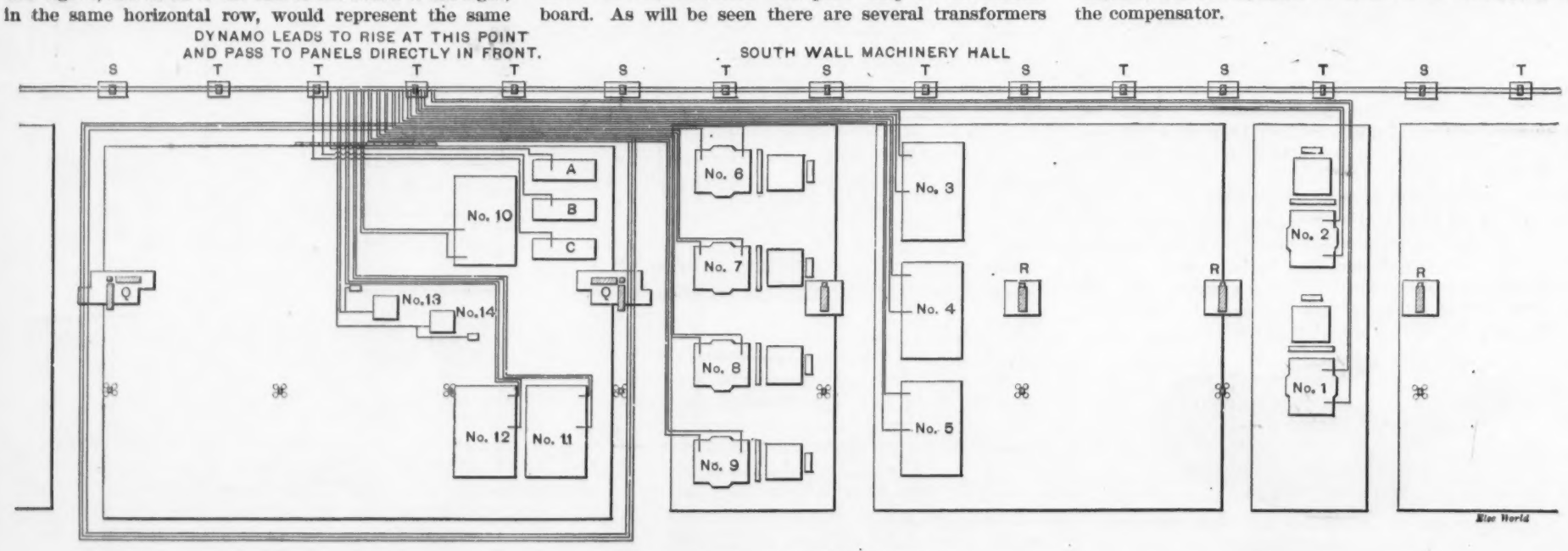


FIG. 9.—RUN OF DYNAMO LEADS.

THE STILLWELL COMPENSATOR.

The compensator is a device for so correcting the reading of the voltmeter as to make that not the reading of the line at the station, but of the potential at the farther end or centre of distribution. It is 1-20th of this potential that the voltmeter registers instead of the potential at the switchboard, and it is the office of the compensator to make the necessary correction. How this is done, can, we think, be very clearly explained. A

small transformer is introduced, its primary being in series with the feed wire. Now, if there is no load on the circuit, there can, of course, be no drop on the line; there will be no flow of current through the primary, and consequently none in the secondary. With a given resistance the drop in potential on the line will be proportional to the current flowing; therefore, as the current in the secondary is proportional to the current in the primary, the secondary current may also be used as a measure of the drop. The secondary winding is therefore connected with the auxiliary coil on the voltmeter solenoid, which is wound in opposition to the solenoid coil. The relative proportions of these two coils is such that their resultant effort upon the core is just that which would be produced by the voltmeter coil were it placed at the distant point instead of at the switchboard. The reading of the voltmeter is, therefore, that of the potential at that distant point, or rather, in this case, just 1-20th of what it is there, and lower by the amount of drop on the line than the actual reading at the switchboard. It will thus be seen that this is but a modification of the Shallenberger instrument which employed the counter E. M. F. generated in a series converter as a compensation.

But the drop is not only proportional to the load, but also to the resistance or distance. Therefore to render the compensator adjustable to various distances the compensating current is regulated by a multipoint switch, by which the instrument may be adjusted to any length of circuit. The curves of the compensator show that it can be adjusted to within less than 1 per cent. It does away entirely with the necessity of pressure wires, and in connection with the Stillwell regulator proves an almost invaluable adjunct to the alternating current switchboard.

THE STILLWELL REGULATOR.

The fundamental principle of the Stillwell regulator is that of a converter which shall increase or decrease the primary potential by an amount determined by the length of the secondary coil. The latter is built in sections which are brought out to a multipoint switch by which all or any number of them may be at will thrown in series with the main circuit, thus adding to the initial primary potential of the circuit that of the secondary coil or such portion of it as is thrown in. Within the limits of the voltage thus added, therefore, the potential of the supply circuit is subject to the most delicately shaded adjustment at the switchboard, independent of whatever may be the potential at the dynamo terminals. In this way it is possible to take from the same generator a number of circuits each to be operated at different drops, and yet maintain the lamps on each at the same potential.

Referring to the diagram it will be seen how the connections are made. The arm of the switch sweeps over the contacts, and by this means connections may be made with any given length of the secondary coil. It is obvious, however, that should the arm be of insufficient width to bridge between adjacent contacts, an interruption of the circuit would occur as it moved from point to point. It is also evident that should the width be sufficiently increased to bridge between adjacent contacts, a short circuit would take place. These difficulties are obviated by making the arm in two parts, one of which is connected to the inner and the other to the outer of two semi-circular rings. These rings are in turn connected to the terminals of the preventive coil, which is so wound as to offer a high inductive resistance to currents tending to flow between the points of the switch, but practically none when both parts of the arm are covered by the same contact piece.

This instrument is only intended to increase electromotive force in the circuit by a few volts, 10 per cent. in this case. To do this it is only necessary to transform a very small portion of the electrical energy passing through the regulator. In practice the efficiency of conversion of this portion is extremely high—say 95 per cent.—and, therefore, constitutes but a very small percentage of the total energy of the circuit.

There is also in connection with this regulator a reversing switch, the position of which determines whether the regulator shall increase or decrease the voltage.

THE AMMETER.

This is of the regular Westinghouse standard type, consisting of a solenoid of large wire in series with the main circuit with a laminated soft iron core. The method of constructing the cores for alternating current magnets adopted by this company is interesting and ingenious, and is due to Mr. Lange, who has long been connected with the company. A sheet of brown paper is wrapped on a wooden cylinder, and this is closely wound from end to end with fine bare soft iron wire. The winding is done on a lathe, and no attempt is made during this operation to keep the different convolutions from touching each other. The paper cylinder, however, has been previously covered with shellac, so that when the latter has dried the wire is firmly attached to the paper. The paper cylinder is removed from the wooden cylinder upon which it was formed, and when dry, cut longitudinally and flattened out. A sheet of paper is thus obtained, one side of which is covered with parallel wires close together. This, after being cut to proper size, is rolled up on itself with the paper inside. The wires, though in contact with each other when the paper was flat, become separated from each other in the rolling, and are therefore insulated from each other by a small air space, and each layer is insulated from the succeeding or preceding one by the thickness of the paper. In this way a most finely divided core with the best of insulation between its components is rapidly and cheaply obtained.

FUSES.

In each panel of all the boards, except the exciter board there are inserted at the bottom two safety fuses. These consist of aluminium foil fastened in lignum vitae boxes, the covers of which are perforated in the centre and are fastened on by two large thumbscrews. The boxes each have two large brass terminal plugs by which the fuse is inserted into the circuit, by introducing these plugs into the springjack terminals of the circuit.

At a future time we hope to take up more in detail than is possible now, the other important factors in this great plant.

Currents from Commercial Circuits for Medical Purposes.

To the Editor of The Electrical World:

I take the liberty of addressing you for the purpose of eliciting a discussion among electrical experts as to the relative safety or danger of electric light current furnished from stations and used for medical purposes. I am a manufacturer of electro-medical instruments and as such have refused to furnish any apparatus for the medical use of the electric light current, for the reason that I have considered it dangerous and liable to cause injury, and even death, to the patient to whom it is applied, and perhaps of the doctor who applies it, as well.

I am well aware that the current can be safely used when generated in the building in which it is used and has no connections with outside electric light wires. The current as generally used, however, I deem dangerous, and for the following reasons: First, that a wire from the arc light or an alternating circuit may cross an incandescent wire; this may readily occur, even in New York City (which I consider the safest city in this country for such use of the current, because the wires are under ground), and yet contact may be caused by an explosion, as it has occurred, thu throwing two wires together, or by a fire in which the wires may be crossed or short-circuited, either by water, by iron pipes, or other conductors which may intervene and connect them.

Where aerial wires are employed, the danger is greater still, as such wires are liable to cross, as it may be occasioned by a break; trouble may also be anticipated where the trolley system is used.

This question of the safety of the medical current from light wires is of great importance to me, for the reason that if electrical experts are willing to agree as to the safety of such currents I should not again refuse to make apparatus for that purpose, but I conscientiously feel that no physician has a right to use, and no manufacturer the right to furnish, any remedy or instrument to be used in medicine which is not under complete control, and may prove dangerous, even if there is but one chance in a million that a human life should be sacrificed thereby unnecessarily.

Another question I would propose is: In case the patient is maimed or killed, who will be to blame—the doctor who is supposed to be a scientific man and familiar with all scientific appliances used in the profession, the agent who sells, the manufacturer who makes it, or the electric company which furnishes the current, knowing that it is used for that purpose?

I should be glad to have an expression of opinion upon the points here mentioned, as it is important that it should be thoroughly ventilated and settled, once for all.

H. E. WAITE, M. D.

Automatic Electric Switch and Signal System on the Reading R. R.

An automatic electric switch and signal system has recently been introduced at the Philadelphia terminal of the Reading Railroad, which is said to be the largest yet installed.

The system will be operated from a single tower, and will control the switches and signals of the terminal from the junction at Callowhill street to the trainshed. The switches and signals will be operated by compressed air, which comes from the power house on Arch street, and is carried through a system of tubing to the valves of various cylinders operating the switches and signals. Connected with these cylinders is a system of electric wires leading from a dynamo located in the power house, and extending to the tower, located a short distance above Race street, where, by the manipulation of small levers, the electric current releases or shuts off the air which operates the switches and signals.

In the signal tower are 36 lever machines, each connected with a switch. Of these, 33 will be in operation for the present, and 20 signals. On a long blackboard facing the leverman is a complete plan of the tracks, switches and signals, which moves in response to the levers, simultaneously with the switches and signals, and keeps the leverman constantly advised of the exact position of each switch and signal.

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE.

(Compiled from the principal foreign electrical journals.)

BY CARL HERING.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Electrical Nomenclature.—Mr. Hospitalier, in an article in "L'In. Elec.," April 25, gives some rules for electrical nomenclature in the form of a proposition for the coming Congress. The object is to have the Congress lay down certain general rules which ought to be followed in establishing names and definitions of quantities and their units; such rules would greatly simplify the work of future congresses. All physical quantities which are distinguished from other physical quantities ought to be characterized and defined precisely, once for all by: (1). A special name. (2). An international symbol. (3). A defining equation in terms of the fundamental or derived quantities. (4). A C. G. S. unit, and, for those often used, a special name with corresponding abbreviations. (5). One or several practical units, which are decimal multiples or fractions of the C. G. S. unit, with corresponding abbreviations. (6). Wherever their nature permits, a fundamental standard for scientific researches. (7). And a practical standard for use in the industry. Regarding the name, he says it may either be a single special name, or one formed of several words, but in the latter case rules should be adopted for designating new quantities; he suggests using the words linear, superficial or sectional, and cubic or volumetric in connection with physical quantities, as, for instance, "linear capacity" of a cable, which is the quotient of its capacity by its length; "linear insulation," which is the product of its insulation resistance and its length, and measured in kilometre-megohms; the terms kilometric capacity and kilometric insulation, he says, are bad, as they combine a quantity with a particular unit; the definition of a physical quantity should be in terms of physical quantities only; the energy in a dielectric or magnet or that of hysteresis is proportional to the volume; the quantity "specific energy," which is defined by the energy divided by the volume would then be simply volumetric or cubic energy. This applies to new names and need not affect existing names, such as density, which is the quotient of the mass of a body and its volume. He protests strongly against what he calls fantastical definitions so often used by the English, which consists of uniting in a definition both physical quantities and units; it is not logical, for instance, to say that a velocity is a length per second; that power is work per second, that frequency is the number of periods per second, etc. Regarding symbols, he says that their physical quantity ought to be represented in a formula by a special symbol which is always the same and is adopted once for all; this would greatly simplify the reading of equations; in order to reduce the number of symbols, the same one could be adopted for physical quantities having the same dimensions. The C. G. S. unit of a physical quantity is deduced from its equation in making all the terms equal to unity, a rule which is universally applied. He suggests that it would be advantageous to give special names to some of these units which are used most frequently, as has been done with the dyne and erg. If a unit is composed of two others, the rule is to combine them with a hyphen if the two units are multiplied, and to separate them by the word "per" if the two units are divided; ampere-hour, metre per second—serve as illustrations. The abbreviations of the C. G. S. units are, according to the adoptions of the Frankfort Congress, indicated by the initial letter or letters in Roman type. The abbreviations for the practical units are found in the same way. Fundamental standards ought to be either in the form of the most accurate possible copy of the true standard like the metre and kilogram, or they ought to be defined with sufficient precision that no ambiguity can arise. The Chicago Congress, he says, will have to define two important fundamental standards; one of resistances, and one of electromotive force, but in order to avoid confusion with standards defined by other congresses, it will be necessary to add some character or subscript to distinguish them; as, for instance, if the ohm is called a "Chicago ohm," "ohm_{93}," "$ohm_{106\cdot3}$," etc., the name ohm itself should be reserved for the true ohm equal to 10^9 power C. G. S. units. He thinks it is not within the province of the Congress to adopt concrete standards; the question is an important one, but not one which it would be possible to decide at an international congress.

Theory of Electrical Quantities.—Mr. Guillaume, in the "Bul. de la Soc. Int. des Elec." for April, discusses the subject of the modern ideas of the theory of electrical quantities. He discusses briefly the objections to the C. G. S. system of fundamental quantities, mentions the suggestions of Ostwald to substitute a unit of energy for that of mass (see note below), giving a few examples; he discusses briefly the system proposed by Williams, based on a system of three rectangular co-ordinates in space, which, among other advantages, avoids a confusion be-

tween such quantities as a dynamic moment and work, which are alike in being equal to a product of a force and a distance; this system may also, in some cases, show the impossibility of a phenomenon; he mentions the results of Ruecker, in which electrical quantities are introduced in the definitions in connection with the quantities mass, length and time; he introduces the quantities specific inductive power K, and the magnetic permeability μ. Illustrations are given of various formulas.

Energy as a Fundamental Unit.—The Lond. "Elec. Rev.," April 28, states that Ostwald, in a communication to the Munich Academy, recommends the substitution of the unit of energy for the unit of mass as one of the three fundamental units of an absolute system, in which case all physical magnitudes would be expressed in energy, length and time. Energy is the only magnitude which is common to all branches of physics, and it forms the single bond which unites the theories of heat, electricity, chemistry and dynamics.

Congress Proposals.—The discussion of the American proposals was continued at the Societe Internationale des Electriciens, and is contained in the April "Bulletin." Mr. Boucherot discusses the definition of self-induction offered by Mr. Blondel (see Digest, April 15), which he says is correct when the self-induction is constant, but is not correct when the medium has a variable permeability; that is, in the very case to which the definition is intended to apply; if the permeability is not constant, the self-induction is a function of the current which introduces a second term in the equation for the counter E. M. F., which, if neglected, may introduce a very great error. He proposes instead the following definition: The coefficient of self-induction is at every instant the ratio of the integral of the counter E. M. F., produced by the variation of the current, to the intensity of the current; he also discusses the subject of inductance, for which he proposes a new definition. Mr. Blondel, in replying, states that his definition is not incorrect; he discusses the subject at some length. At the suggestion of Mr. Hospitalier, a special committee was appointed to formulate the views of that society on the proposals.

Terminals of Instruments.—Mr. Rennie, in a paper reprinted in the Lond. "Elec. Eng.," April 28, calls attention to the fact that so little attention is given to proper terminals; but he offers no remedy, except to say that the surfaces of contact ought to be larger; the ordinary pillar and screw terminal, he says, ought never to be seen on even the smallest ampere meter; theoretically, the contact surface for 100 amperes need not exceed 64 square millimetres (one-tenth of a square inch), but in that case they must be absolutely clean and in continuous contact throughout; he suggests using ten or one hundred times this area; an admirable solution of the problem, he says, is found in Lord Kelvin's multiple contact piece, as made with his instrument; a current of 100 amperes passing through a contact resistance of one-thousandth of an ohm means an expenditure of from $5 to $8 per year for each instrument; he thinks there need be no change in the ideal terminal, whether it be for alternating or continuous currents.

Electric and Magnetic Instruments.—The Lond. "Elec. Rev.," April 28, calls attention to an article by Quincke in the "Ann. d. Physik. u. Chem.," No. 1, 1893, p. 25, in which is described a simple, economical and accurate instrument to be used as a galvanometer and magnometer, and which is said to be an entirely new departure from the usual forms.

DYNAMOS, MOTORS AND TRANSFORMERS.

Dynamo Design.—Mr. Snell's serial on "Electricity as a Motive Power" is continued in the London "Electrician," April 28. Dynamo designers will doubtless find much in this serial which is worth their attention. The following are a few extracts from the present installment. If the cost of production is the principal factor, bipolar fields are preferable for armatures up to 12 inches in diameter, from 12 to 15 inches four-pole, and from 18 inches upward multipolar fields should be employed. Curves showing the weight and output and cost per kilowatt follow very different laws in different types of machines; he gives two such curves, which show that the weight and output curve follow practically a straight line law, and that the output is proportional to the cube of the linear dimensions, practically to the armature diameter and length. In bipolar machines, at the inductions usually employed, namely, 77,000 to 97,000 in wrought iron and 45,000 to 50,000 in cast iron, the relative magnet cross-sections should be in the ratio of 3 to 1.6, the effective armature section being taken as unity; cast steel magnets have been used with some success; the curve for this is nearer that of wrought iron than that of cast iron. Although the circle is theoretically the best form, in practice rectangular cores with a length equal to twice or three times the depth have been found preferable. The relative area of cross-section of armature and field core should be about 1 to 1.6 for wrought iron magnets and 1 to 3 for cast iron; the length of the cores cannot be determined without calculation, although a few trial and error determinations may suffice; the number of square inches in the external surface of the winding, not including the ends, should be about twice the number of watts lost in heat if the depth of winding does not exceed 2½ inches; in large machines a greater margin is preferable. With drum windings the lead of the brushes is comparatively small and the angle embraced by the pole pieces may be larger than with the Gramme ring armatures; a sale rule is to make it 135° for drums and 125° for Gramme's; the ratio of the pole surfaces to the cross-section of the core is determined mainly by the induction in the gap, which it is not economical to push beyond 3,000. Including leakage, the ratio of pole area to cross-section will be approximately 1 to 2.75 for wrought iron and 1 to 1.6 for cast iron; but there is always a loss in leakage, which must be allowed for. He gives a table of the leakage coefficients for various types of magnets; that is, the relation between the field lines and the armature lines; they do not differ much and vary from 1.2 to 1.6, a general mean being about 1.4. Yoke pieces should be made about 1.2 times as large in cross-section as the magnet cores if of the same material, or 1.6 to 2.0 if they are made of cast and the magnets of wrought iron.

Alternating Current Motor.—Mr. Snell's paper on "The Distribution of Power by Alternating Current Motors" is concluded in the London "Electrical Engineer," April 28 (also continued in London "Electrician," same date). Detailed data are given regarding the experiments with his three-phase motor when run with the star or open coil connections; tables are given showing the speed, amperes, volts and brake horse power under various conditions. He shows that the variations of current between running light and full load and when the armature is stationary are very small, showing a large idle current which is most prejudicial and which he thinks will militate seriously against multiphase motors; if the revolving part of the motor (which he calls the armature), instead of the fixed part, receives the tri-phase current, these troubles will be much less, as the moving part will contain less iron. His experiments show the importance of reducing the magnetizing current to a minimum; such a motor may be regarded as an open magnetic circuit transformer, and the only way to lessen the waste current is to make the magnetic resistance as low as possible, which Brown accomplishes by embedding a wire in iron, and which Snell suggests doing by winding the field coils like a drum armature. (How this should accomplish the object he does not state.) He advocates making the field—that is, the part which is supplied with the current—the revolving part, notwithstanding that it necessitates brushes and rings, as in that case the most marked defects of hysteresis, eddy currents and self-induction are limited to the relatively small moving part of the machine, the frequency in the massive stationary portions being then equal to only the difference between the speeds of the armature and revolving field. Attempts have been made to combine the advantages of a self-exciting rotary field and a synchronous motor, consisting in general of winding the armature with two circuits, one closed on itself and the second supplied with the direct current; when the field is excited by a rotary current, the induced currents in the closed circuit will start the armature, and the permanent poles due to the direct current will have little influence until the speed of synchronism is approached, when the induced currents will decrease, until finally the torque is entirely due to the fixed poles; but there are many disadvantages in such an arrangement; its efficiency is necessarily low at starting and when its speed is below synchronism, but when once started it will run at constant speed with high efficiency; the initial torque is not as great as in the di-phase or tri-phase winding; it is not likely that such motors will supersede single-phase alternators. He next explains briefly the motors described by Brown, Thomson, Hutin and Le Blanc (all of which have been described in these columns), which are self-exciting and self-starting, two very important features; he considers these the best type of single-phase motors up to date; they are susceptible of considerable improvement, and he thinks the problem is not yet satisfactorily solved. The discussion, of which an abstract is given, contains little of importance.

High Frequency Alternator.—An article under this heading in the London "Electrical Review," April 28, states that more attention ought to be paid to this subject, as public distribution does not necessarily control or limit the whole sphere of electrical utility; when the current and the distance are not great, for instance, it might be desirable to use a higher frequency than 5,000 or 6,000, now so generally popular. (If it means per minute, then this is the frequency ordinarily used in distribution; the term frequency, however, is in that case used incorrectly, as the frequency is the number of periods per second; it is not unlikely that the figures are intended to represent the periods per minute.) The article is accompanied by an illustration of a machine designed by Mr. Pyke for laboratory purposes, giving a frequency of 40,000 (presumably per minute). It consists of two direct current motors and an alternator; one motor drives the field of the alternator in one direction, and the other motor drives the armature in the opposite direction; the windings of the field and armature of the alternator are identical in electrical construction, consisting simply of coils round iron wire cores. The two parts have coils of different sized wire and different windings, so that either may be used as an armature with the other as the field; the E. M. F. generated may be varied from a few volts up to 400; the alternator runs 10 lamps of 16 c. p.; as the relative speeds of the two motors may be varied, very varying outputs may be obtained from the alternator. (If an alternating current is at one's disposal, the frequency of the alternator might be increased by using the alternating current to excite the field of the alternator.)

Transformer.—"L'Ind. Elec," April 25, describes and illustrates the transformer of Labour, made for laboratory purposes for a French institute. It is wound with a large number of coils connected to terminals, enabling them to be coupled in series or parallel, or any other combination; the iron core is made of U shaped sheets of iron, as used in a Rechniewski dynamo, the space occupied by the armature being filled with a laminated iron plug fitting it with great nicety; by removing this plug, the coils may be slipped off from their core. Detailed data are given of the dimensions, the windings, etc., as also of tests made, the latter showing an efficiency of 97.4% when the output was 18,000 watts.

Compound Dynamos in Parallel.—Mr. Guy, in the Lond. "Elec. Eng.," April 21, discusses the subject of compound dynamos in parallel, giving detailed instructions how they should be run, accompanying the same by a clear diagram. The article forms part of a long serial on "Electric Light and Power," and is written in the style of a textbook for amateurs.

ARC AND INCANDESCENT LIGHTS.

Projectors.—The article on projectors, mentioned last week, is concluded in the Lond. "Electrician," April 28. As most of the light comes from the crater, some makers displace the two carbons in order to get the full benefit of the crater; for angles over a certain amount, however, the best arrangement is to place the two carbons axially and horizontally, whereby the full light of the crater is thrown on the mirror, except the small portion due to the shadow of the negative carbon. Mr. Nerz shows how the best useful angle of the mirror can be calculated; with parabolic mirrors there remains only to choose the proper focal length for a reflector of given diameter, in order to secure the greatest possible output; he shows mathematically that the intensity of illumination in the field due to the mirror is as great as if it were produced by a source of illumination which has increased from the size of the source of light, that is, the crater, to the size of the mirror without diminution in its specific intensity. As the surface of the crater is approximately proportional to the power, but the specific intensity remains fairly constant, it follows that the brilliancy will not be increased by an increase of the power, but only the size of the illuminated field. As far as brilliancy is concerned, the efficiency of a projector cannot be increased by increasing the current, which latter should be chosen for a certain sized reflector only, with reference to the angle of illumination; after having determined the proper focal length, the next important point is, therefore, to choose the proper current for a maximum effect with the least amount of energy. To increase the output of a projector, it is necessary to increase its dimensions; the practical limit is about 3 feet in diameter, larger ones would be unwieldy on shipboard, and would be apt to be broken by the guns. To search for torpedo boats the beam must be spread horizontally, and, as the intensity then diminishes in proportion as the beam is widened, the angle of illumination and therefore the current should be as large as possible, and under these circumstances the intensity of the illumination can be increased by increasing the current, and it will increase in proportion to the square root of the current. For large currents a larger useful angle must be used in order to prevent overheating the mirror. For spreading the beam horizontally various combinations of cylindrical lenses are shown and described, which are used also for signaling.

Search Lights.—During the recent war in Egypt, in which electrical search lights were used, it was found possible to read a newspaper with the greatest ease at a distance of 4½ miles from the projector. The number of insects which collected around the search light was so great that they had to be removed continually, and it was difficult to find a man who would operate the projector on account of the attacks from these insects.

Electric Lighthouses.—"L'Ind. Elec.," April 25, contains a long article on this subject by Mr. Bochet. It appears to be well written, but is devoted almost entirely to lighthouses in general, and to their history, only a small portion being devoted to electric lighting. Among the more recent electric lighthouses, he mentions three in which the light is equal to about six million candles, and can be seen from a distance of 62 miles. The new lighthouse at La Heve will be much more powerful than this, and will be the most powerful in the world. The great brightness of the light is necessary in order to counteract the absorption of the light in a fog.

Arc vs. Incandescent Lamps.—In discussing an article in an American journal, showing the relative light efficiencies of the arc and incandescent lamps, the Lond. "Elec. Rev." calls attention to the fact that the number of candles per watt of an arc lamp is a very uncertain quantity, and that in making such comparisons, therefore, a better knowledge should be had of the actual quantity of light generated by arc lamps.

Blackening of Lamp Bulbs.—Mr. Cramer states that platinum evaporates in a vacuum if subjected to abnormally high voltages, and subsequently condenses on the bulb.

TRANSMISSION OF POWER.

Compressed Air Transmission.—Prof. Unwin, in a recent lecture, stated that compressed air transmission is practical up to at least 20 miles; 10,000 h. p. can be transmitted 30 miles in a 30-inch main at 132.3 pounds per square inch, with a loss of pressure of only 12 per cent.; the efficiency is 40 to 50 per cent. if the air is used cold, and 59 to 73 per cent if it is reheated.

RAILWAYS.

Cleaning Rails.—In a recent paper before the Society of Engineers, Mr. Conradi called attention to the importance of keeping rails for tramways clean. He devised a rail-cleaning machine, which is now being used on some of the cars at Reading (England); experiments showed that the tractional resistance of the car running on rails thus cleaned by the previous car was from 25 to 30 pounds less than when running on dirty rails. Cleaning by hand once a day, he says, costs 25 cents per mile of single line in the fine season, and 50 cents per mile in the severe season; watering by cart twice a day, 62 cents per mile; cleaning with the author's machine as often as required, 12 cents a day.

Automatic Railway Signals.—The Lond. "Elec. Eng.," April 28, mentions a system which is at present being introduced in England. It states what this system will do, but does not describe it.

INSTALLATIONS, CENTRAL STATIONS, ETC.

Economy of Electric Supply.—Mr. Kapp's paper. mentioned last week, is concluded in the Lond. "Elec. Eng.," April 28. The most important part is an interesting table giving comparative data of about a dozen private installations, and accompanied by short descriptions of the most important of the plants. The table contains much that is of interest, and is recommended to those interested in isolated plants. In a private installation for domestic purposes, a storage battery, he says, is an absolute necessity. If the installation is very large, the capacity of the battery should be comparatively small, but should be capable of giving a rapid discharge; in small installations the battery should have a large capacity, and should be capable of holding the charge for a long period. In a private installation for business purposes, the battery may be small and should be used merely to steady the voltage and as a reserve. In order to work economically, every installation must be designed with proper regard to its special requirements. He calls attention to the importance of the load factor, which should be taken into consideration in designing a plant; he defines the load factor for private installations as the ratio (in per cent.) of the actual yearly supply to the supply which would be required if the maximum number of lamps lighted simultaneously at any time were kept lighted over one year; in his table the load factor in public buildings is about 25 to 30 per cent., while in private house installations it is about 6 to 7 per cent. He says that no installation should be put up without meters, in order that a thorough knowledge can be had at any time of the running conditions. The results of his comparisons in the table show that electricity made at home for domestic purposes costs about twice as much as when supplied from central stations, but when made at home for business purposes it costs only about half as much. (This, however, is only quite general, as it would seem to depend greatly on the size of the plant.)

Cost of Electric Lighting.—A paper on this subject is reprinted in the Lond. "Elec. Eng.," April 28. The author gives his experience, which extends over 17 years. He gives numerous average costs of cables, wiring, lights, fixtures, total cost of installation, income per lamp in central stations, etc. For ordinary house work he finds that electric lighting is about 10 per cent. more costly than gas, which figure, he says, is borne out by facts. In office lighting the proportion is about 4 to 3 in favor of gas. In factory lighting the cost of the power is often negligible, as it forms but a small part of the total power. In this connection he calls attention to the fact that if rigid bearings for shafting are used, the power absorbed in the shaftings is from 50 to 60 per cent. of the indicated horse power of the engine at full load. In such cases the adoption of modern improvements in hangers would save enough power to light the premises. He uses the formula $L \times c \div 125 = A$, in which L is the total length in feet of lead and return; c the current in amperes, A the cross-section of copper in square mils to give a total loss of one volt for given length and current.

Gas versus Electricity.—In a paper by Mr. A'Court, reprinted in the Lond. "Elec. Eng.," April 28, he reviews this much discussed subject, but gives little that is not already well known. For street lighting he finds the first cost to be as 1 to 3.9, and the running expenses as 1 to 4.8, both in favor of electricity. In small streets gas is cheaper than incandescent lights.

Central Stations in England.—The Lond. "Elec. Eng.," April 28, in a large table gives some condensed data about the central stations in England. The average price charged private consumers appears to be about 15 cents per kilowatt-hour, though in some cases it is as low as 7 cents.

WIRES, WIRING AND CONDUITS.

Couplers for Underground Cables.—Mr. Tasker, in th Lond. "Elec. Rev.," April 28, describes and illustrates a simple coupler for conveniently joining and disconnecting underground cables. It consists essentially of a male and female cone shaped piece fitted with nicety, soldered to the ends to be joined, and a sleeve with a right and left handed screw thread, which, on being screwed over the joint, presses the two conical surfaces into close and rigid contact. A modification is shown for connecting a number of mains and feeders together.

SIGNALS.

Burglar Alarm.—In a novel form of alarm invented by a Frenchman, the current from an ordinary burglar alarm or bell circuit ignites and explodes a cartridge on the roof of the house, besides starting all the bells to ring. The cartridge, in imitating a pistol shot, is said to be very effective in frightening the burglar.

ELECTRO-CHEMISTRY.

Application of Electricity to Chemistry.—Mr. Swinburne's second lecture is published in the Lond. "Elec. Rev." and the Lond. "Electrician," April 28. In it, he speaks more particularly of the electrolysis of fused salts, which he thinks has not been studied as thoroughly as it should be, and he thinks it a matter of very great importance. In all solutions of salts, oxygen is present, but this is not the case with fused salts, and therefore results can be obtained which are not possible with solutions. Many attempts have been made to produce sodium vapor, as it is mixed with the vapor of salt; the they have not as yet been satisfactory, as many difficulties are involved; there is difficulty in collecting the sodium vapor, as it is mixed with the vapor of salt; the electrodes are easily attacked, and hot sodium attacks silicates. Strontium, magnesium, calcium, aluminum, barium, sodium, potassium, lithium, tonsten and boron may all be obtained by electrolysis from their fused salts. In the electrolysis of fused sodium and potassium chloride, the yield of the metal is said to be considerably below the theoretical value. Many fused salts appear to conduct like a metal without any decomposition, but this, he says, seems impossible. He believes the apparent conduction may be due to the fact that the salts are good solvents, and that the products therefore dissolve. Aluminium is obtained from the mineral cryolite, which is fused and electrolyzed in an iron vessel, being kept hot by the current. He thinks there is a great future for the electrolysis of fused salts. When an electrolyte is subjected to an electric current there is a migration or transference of the ions, which, he says, explains the action of electricity in tanning, as it causes the tannin to pass through the walls of the cells. Mechanical agitation does not accelerate tanning very much, and electricity alone is of very little use, but the combination of the two is most effective. Glass is one of the best insulators, but the electrolysis of glass, he says, is quite as easy as the electrolysis of anything else. Ozone can be developed by electrolysis from aqueous solutions of nitric, sulphuric or phosphoric acids.

Electrolytic Separations—The London "Elec. Rev.," April 28, gives a short summary of recent papers on this subject. Dorsspach ("Chemiker Zeitung," v. 16, p. 118) states that from an ammoniacal solution of copper the metal is deposited without contamination, even though silver, bismuth, antimony, arsenic or tin are present; mercury and cadium, however, may interfere; if the action is too prolonged, nickel, cobalt and tin may be deposited. Smith ("American Chemical Journal," v. 14, p. 435) states that iridium is not precipitated by the current if there is an excess of phosphoric acid or an alkali phosphate, whereas palladium and platinum separate readily. Smith & Wallace (Journal Analytical and Applied Chemistry, Vol. 6, p. 87) state that in potassium cyanide solutions gold is readily separated from arsenic, molybdenum or osmium, and from wolfram if dissolved in the potassium cyanide, but if dissolved in potash the separation is unsatisfactory; osmium separates readily from cadmium, silver and mercury in a potassium cyanide solution, and cadmium from nickel if potash is present. Rudorff (Zeitschrift Angewandte Chem., 1892, p. 695) gives methods for the separation of various metals. Medicus (Ber. d. Deutsche Chem. Ges.) states that lead may be separated accurately and rapidly from galena if dissolved in hydrochloric acid, then in potash, and precipitated as carbonate by means of carbon dioxide, then dissolved in nitric acid and electrolyzed.

Electrolytic Chlorine and Soda.—Dr. J. Hopkinson recently made a report on the Holland and Richardson patents, in which he states that the difficulty heretofore encountered in the speedy disintegration of the carbon anodes appears to have been completely surmounted in the present apparatus. The anodes in this consist of lumps of gas retort carbon of the roughest possible shape, having a slot cut on each side of each lump, and after being laid closely together lead is cast through the slot; they are said to be very cheap, as the carbon is used in rough lumps, in which form it costs very little. In discussing this, as well as other points of this report, Mr. Andreoli, in the London 'Electrical Review," April 28, states that this feature is not new, as the electrodes are exactly the same as those used in the Le Sueur process. (See Journal Society Chemical Industry, Dec. 31, 1892.) Mr. Andreoli says that unless the carbons are completely immersed they are cut and destroyed at the level of the liquid, and unless there is parallelism between the electrodes the yield is not efficient, as it is very important that the two electrodes should be quite close and parallel to each other. In Hopkinson's report it appears that each tank requires six volts; Mr. Andreoli says that in the Le Sueur, Greenwood and other processes only 4½ volts are required; the difference between the two makes quite a difference in the item of cost.

MISCELLANEOUS.

Ozone.—The London "Electrical Review," April 28, contains the concluding article of the appendix to the serial on the application of ozone. Quoting from an article written in 1868, it states that one gramme of hydrogen under the action of oxygen generates 34,451 calories, and with ozonized air, 34,595.6, or 44.6 units more (subtraction, however, gives 144.6, showing an error somewhere); one litre of hydrogen, combined with ozonized oxygen containing one sixty-sixth of ozone, liberates 3,091 calories, from which the calorific equivalent of ozone is found to be 346. High temperatures for metallurgic and other purposes may be obtained by substituting ozone for air or oxygen; ozone passed through porous substances loses its odor and its properties. Regarding bleaching it states that unless applied under certain conditions and in a certain manner, it does not bleach at all. Alone, ozone does not decolorize in any manner approaching the rapidity with which it destroys or disintegrates india-rubber. The combination of ozone with chlorine, recommended by Dr. Thorne about six years ago, it states, is the best. Passed through the weak solution of hypochlorite of calcium, it bleaches rapidly; nitrogen retards the bleaching, and air or oxygen does not help it at all. The saving in thus bleaching paper pulp is 40 to 50 per cent. Dr. Thorne states that 50 pounds of esparto, straw and pulp were bleached in this manner with 200 cubic feet of ozone. It acts identically with chlorine. Negative results obtained by experimenters are stated to be due to a want of knowledge of how to do it. Damp tissues are decolorized at the ordinary temperature, but dry ones are not. He gives a list of the number of dyes and the effect of ozone on them. Mr. Chappuis showed that it destroyed the germs, causing fermentation, putrefaction and the development of mildew. He collected some of these and brought them in contact with beer yeast, which kept clear for twenty days with the ozonized germs, while with non-ozonized germs it became turbid in a few days, showing that all organisms in the air which are developed in beer yeast are killed by ozone. Organic matters—smoke, sulphur compounds and other impurities in the air—destroy ozone. As ozonizing installations are inexpensive, it suggests their use on trans-atlantic steamers, as it would relieve the passengers from the worry and trouble of a quarantine. The installations might be carried on small boats sent out to disinfect vessels. It quotes from the proceedings of the Imperial German Sanitary Board, vol. 8, part 1, in which Dr. Ohlmuller states that: Anthrax, typhus and cholera bacilli, as also anthrax spores, are destroyed by ozone in a few minutes. Typhus and cholera bacilli in the sewage and water of the Spree were destroyed. It has no effect on dry bacteria and bacilli. Bacteria which have penetrated into paper, threads, etc., are more difficult to destroy. Two litres of ozonized air killed the pus bacilli. The destruction of germs is a mere question of quantity of ozone, and therefore negative results were probably due to a want of a sufficient quantity. With 1 h. p. he obtained 3 milligrams of ozone per second, and with another apparatus 9 milligrams. Tables are given showing the amount of ozone generated in certain times; also, tables giving data regarding the typhus and cholera bacilli, showing the reduction in their numbers in a given solution at the end of certain times of treatment. The quantity of ozone was calculated by the Baumart method ("Poggendorff Ann.," vol. 84, p. 40), in which it is passed through a 5 per cent. solution of iodide of potassium, the iodide liberated being measured by means of a hyposulphite of sodium and bichromate of potassium solution. In the conclusion of that report, it is stated that ozone acts in a strong manner on bacteria floating in water, provided the water is not contaminated too much by inanimate organic substances.

The Electric Motor for Operating Machinery.

Carl Hoffmann and Ernst Richter, of Berlin, Germany, have recently (May 2) been granted an American patent on the utilization of electric motors having always a constant speed, in such a manner that the speed of the machinery driven by them can be varied as required.

The motor is mounted on the end of a pivoted lever, the weight of the motor and lever thus always keeping the driving belt taut; the pulley driven by the motor belt is also mounted on a pivoted frame, whose position is regulated through a foot treadle, and the machine is driven from a pulley on this frame, either by a belt or by friction transmission. In either case the speed is regulated through the treadle by slackening the latter belt or by reducing the friction pressure, the motor moving up or down with the pivoted frame when the position of the latter is changed.

Most of the machinery, we are informed, in the factories of Siemens & Halske, in Berlin and Charlottenburg, and also in the American works in Chicago, is operated on this principle, not a foot of shafting being used in the large Charlottenburg works.

The Prismatic Incandescent Bulb on the Edison Light Tower at the World's Fair.

At the top of the Edison column, which will form the central exhibit of the Electricity Building at the World's Fair, and which was illustrated in The Electrical World of April 8, 1893, will be a huge prismatic incandescent bulb made for the General Electric Company by F. McLewee & Son, 25 Waverly Place, corner Greene street, New York City, which is shown in the accompanying illustration. This bulb is 10 feet high and 4 feet in width at its greatest diameter, and consists of 40,000 prisms. These prisms are made out of cut glass three-fourths of an inch in diameter and ground like a diamond. To place each one in its position required the services of two men, one working on the outside and the other on the inside of the bulb. The frame is made of

Prismatic Incandescent Bulb on the Edison Tower.

angle iron and covered with a wire hood, and care was taken to develop its surface from that of an ordinary lamp so that the exact curvature of the original was preserved. The prisms were attached to the side of the wire hood, and eight men were employed for five weeks in the construction of the whole bulb. Its total weight is somewhat over 1,000 pounds. It is stated that it is the intention to light the prisms by arc lights of various colors, which will cause them to flash with the brilliancy of diamonds.

F. McLewee & Son are especially fitted for this work by an experience of some 50 years in the business of manufacturing gas fixtures, illuminated signs and lighting specialties, and the result of their work is a success in every respect.

Duplex Electric Sinking Pump.

The difficulties heretofore met with in obtaining an electric sinking pump, at once light in weight, compact in form, of good capacity and efficiency, and not liable to damage from moisture or hard usage, have been successfully overcome, it is claimed, in the pump illustrated, which is manufactured in various sizes by the General Electric Company, of Boston and New York. The motor, with gearing and operating mechanism, is entirely contained in a cast-steel casing, absolutely watertight. The pumps are of the duplex, double-acting type, with outside packed plungers. The only moving parts visible are short sections of the plungers and rods. All wearing parts are readily accessible for examination and can be quickly and easily replaced. This pump is not susceptible to damage from water, and its form is such that it will stand considerable hard usage, without injury. It will work as well under water as out of it, in fact, rather better, the cooling action of the water increasing the efficiency of the electric motor. If, therefore, the precaution is taken to use thoroughly insulated cables for conveying the electric energy to this pump, it may be "drowned" by a sudden rush of water in the mine and still continue operating. Even should the case leak slightly, the motor in the upper part of the case, within a waterproof chamber of its own and separated from the gearing, would remain long unaffected. There are no exposed working parts liable to damage, or to cause injury to those who may be working about the pump. This pump is economical in the use of power, and has a very high efficiency. It has a capacity of 125 gallons per minute against a vertical head of 200 feet, occupies a space of only 24×26×86 inches, and weighs complete 3,000 pounds.

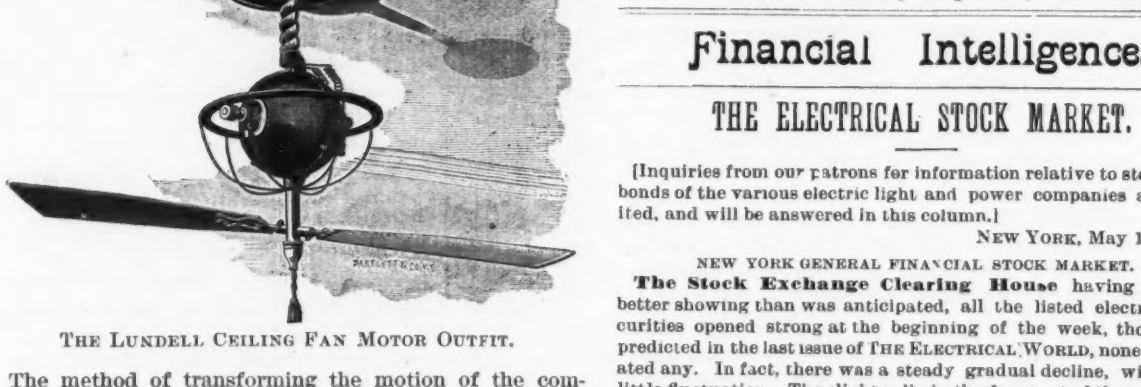


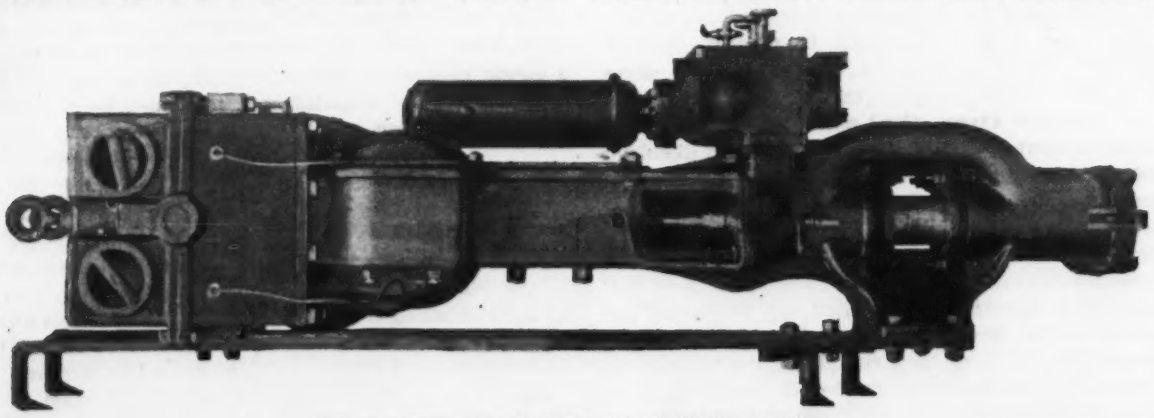
FIG. 2.—DUPLEX ELECTRIC SINKING PUMP.

The Lundell Ceiling Fan Motor Outfit.

In the accompanying illustration is an ingenious combination of a big two-blade fan and a small compact motor. The motor is the invention of Robert Lundell, and the outfit is placed on the market by the Interior Conduit and Insulation Company, 44 Broad St., New York. The device is so constructed as to depend from any ceiling at the correct distance for the required effect, whether a heavy blast, a light, gentle breeze, or any gradation between the two extremes is wanted. The blades of the fan are constructed of hard wood, and their pitch can be changed to suit requirements by loosening the screws which hold them in position and resetting them.

The Lundell Ceiling Fan Motor Outfit.

The method of transforming the motion of the commutator shaft of the motor into a motion at right angles to it is worked out so cleverly as to obtain, it is claimed, an absolutely noiseless result at maximum speed. Upon one end of the motor shaft a small friction wheel is attached. Encircling the motor and resting on this wheel is a thin circular ring plate, which receives its motion by friction from the small wheel. This circular ring plate is in turn connected with the fan shaft by four curved metal braces, making a solid and strong construction.



FIF. 1.—DUPLEX ELECTRIC SINKING PUMP.

The relation of the speed of the fan to that of the motor thus becomes as one to eight. To operate this outfit, only six-tenths of an ampere of current is required, or about the same amount as is required for an ordinary 16 c. p. lamp. The economy in working this outfit, therefore, is readily appreciated.

The H. N. H. Fan Motor.

A piece of apparatus that is likely to create a breeze during the coming season is the new H. N. H. fan motor, which has been placed on the market by the H. N. H. Electric Company, 136 Liberty street, New York City. It represents the combined efforts of Messrs. Newton Harrison, Mortimer Norden and Arthur Hamerschlag, who compose the firm. It is of the inverted horseshoe type, laminated throughout, the field being of one stamp, and the armature of the toothed Siemens type. The carbon brushes are of the plunging type, with a spring in the rear to keep them constantly feeding on the commutator, which is a fac-simile of any large commutator, with mica insulation. The wire on the field is protected by a polished metal covering, and on top of the machine is a hard rubber base switch highly finished, which also serves as a protection to the armature.

The fan is made specially for the H. N. H. Electric Company, and every part of it, including the riveting, is done by punch and dies, even the hub being stamped from one piece. The journals are long, the shaft of large diameter to lessen friction and wear, and oil cups of an

The N. H. N. Fan Motor.

improved design are provided. The wire guard is strong and durable, and securely fastened to the machine. All parts of the machine are of the highest finish.

At a recent test it is claimed that as to weight, compactness, efficiency and smooth running the very highest results were obtained; with 115 volts and .82 ampere the machine turned a 12-inch fan at 2,000 revolutions, with scarcely a perceptible sound, and the weight of the machine complete was only 14 pounds, 14 ounces.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

[Inquiries from our patrons for information relative to stocks and bonds of the various electric light and power companies are solicited, and will be answered in this column.]

New York, May 15, 1893.

NEW YORK GENERAL FINANCIAL STOCK MARKET.

The Stock Exchange Clearing House having made a better showing than was anticipated, all the listed electrical securities opened strong at the beginning of the week, though, as predicted in the last issue of The Electrical World, none appreciated any. In fact, there was a steady gradual decline, with very little fluctuation. The slight rally in the fore part of the week was evidently an attempt to force a bull market, but all efforts were unavailing, as present conditions do not warrant a good, healthy rise. The outside relief which came to one of the leading brokerage and banking houses also averted any further great slumps. The present electrical controversy between the leading concerns of the United States has brought electrical industrials still more conspicuously before the public, thus making electrical securities more widely known. Whatever may be the outcome of the fight between the two great rivals, it is a little too soon to predict what bearing it will have, if any, on the stock. Of the various electrical securities the leading ones are now listed on the Stock Exchange, and have become so thoroughly identified with the other industrials that they are affected more or less by the fluctuations of them. The past week did not present the activity anticipated, for though there was a good deal of liquidation and a general unloading in some quarters, the week was uneventful so far as any startling changes in electrical securities were concerned. Until the financial times improve it is doubtful if there can be any appreciable and upward tendency in the electrical stock market, though with the intense rivalry and cutting competition which exist in electrical industrials something may crop out at any time which will start a great slump or tremendous rise in one or the other of the big companies.

Edison Electric Illuminating, of New York, valuable as it is, fell off two or three points during the week. Opening at 115½ it fluctuated but slightly, sales being few, and finally landing at 114½. This figure is thought by many to be extremely low and an excellent purchase as an investment. With the sweeping franchise held by this company, and the sure and steady increase in the use of the electric current for numerous purposes, the stock must have an appreciation in the future. In fact, in comparison with the quotations of the Edison Electric Illuminating companies of the other principal cities, the New York securities are next to the lowest in the list, Chicago leading, quoted at 220 bid.

General Electric stock is having a turbulent time of it. There seems to be quite a universal opinion that everything is not just right in the affairs of this company. Many are the assertions and charges made of the hard time the concern is having to pull through the present difficulty. The General Electric people seem as yet to be able to answer all charges and rumors which may come before them. They made a most sweeping denial of the report that a reorganization of the company would have to be made to overcome a large floating debt or that new securities were to be issued. The company say their indebtedness has been reduced $.,000,000 since the close of the fiscal year. Whatever the affairs of the company may be, one fact is certain, and that is, whenever there is a bear raid of any kind General Electric suffers

heavily and seems to be especially singled out for manipulation. The stock closed eight points lower on Saturday than the last sale of a week ago, though it made no great drops during the week. General Electric started at 80½ on Monday and steadily lowered like the other electrical stocks, falling as low as 70 on two different occasions. An extraordinary amount of sales of this stock was made during the week, the last one being 300 at 73.

The Boston News Bureau states that some large Boston capitalists, not identified with the General Electric Company, have recently looked into its affairs for their personal information, and are satisfied that the company is all rig t. They did not, however, believe that the company should hold so many local electric lighting stocks that might be sold at a considerable premium. They concluded that the General Electric Company should have no debt at all, as the borrowing ability of a single company like the General Electric is less than the aggregate borrowing ability of the two old companies, Thomson-Houston and Edison. This is true of all industrial and corporate enterprises, and is the source of much distrust to-day, for while a cotton mill with $1,000,000 capital can borrow $1,000,000 at any time for an overturn of goods, a cotton mill with $10 000,000 capital could not borrow $5,000,000 for the same purpose. As a matter of fact, the General Electric Company has twice as much cash on hand as it has of obligations maturing the next 60 days. Of the stocks and bonds now held by the General Electric Company a very large percentage has been received by the company in settlement of territorial rights and not in payment for apparatus. The company has reduced the amount of such stock and bonds largely during the past six months.

The following official statement was given out by the General Electric Company on Wednesday, May 10: The announcement that the General Electric Company is going to be reorganized, or needs any reorganization, is absolutely false. The announcement that it has a heavy and pressing floating debt, or is going to issue, or is contemplating issuing any additional securities, is likewise absolutely false. The announcement that the company guarantees any bonds, or has made sales payable in stocks or bonds, is likewise absolutely false. Of the contracts now on its books over 80 per cent. are for cash, and the remainder, less than 20 per cent., are for well secured notes. The company has been, and is, in a perfectly sound and easy financial condition, and both as to its finances and its earning capacity has never been in as good shape as to day. Its obligations and those of its underlying companies have been decreased by more than $2,000,000 since the annual statement at the close of the fiscal year. Holders of the stock of the company may hold their investment with perfect safety as far as intrinsic value is concerned. It is of course impossible to contradict each and every falsehood as fast as invented, but none of the rumors so far circulated reflecting on the company has even the most remote foundation in fact.

The Westinghouse Electric and Manufacturing Company issued their annual statement, which is given elsewhere, the last of the week. The statement, like the recent one of the General Electric, is lacking in detailed information, which puts the company in the same position for criticism as the General Electric. It is known that the Westinghouse company has greatly reduced running expenses by dispensing with many of its agents, thus cutting off salaries and commissions. The policy of the company has been to solicit big railway and other contracts direct from headquarters, and they have been very successful in getting many of the best and largest contracts made. They are undoubtedly doing a tremendous business, but the intense competition to which they are subjected makes it doubtful if very high prices can be realized. The stock is now offered at, common 32 and preferred 47, though there has been very little, if any, trading in it.

Western Union there was constant trading in, with slight variations in quotations. The stock started at 85½ and closed at 85¼.

Unlisted electrical securities have been very inactive, with very few sales, and whenever any occurred always at declining figures, though but slightly lower.

The Fort Wayne Electric Company has declared a semi-annual dividend of 50 cents per share, payable May 15 to stockholders of record May 12. The net earnings for six months to March 1, 1893, were $166,386, leaving a balance in excess of 100 per cent. of the amount necessary to pay dividend to be carried to surplus account.

The Detroit Electrical Works.—The adjourned meeting held May 6 was deferred until Thursday, May 11, pending further investigation by the New York parties who proposed to assume the company's indebtedness and furnish sufficient working capital.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Brush Ill., New York	50	25	30
East River Electric Light	100	..	65
Electric Con. & Supply Co. pref.	15	15	16
" " " " com.	15	15	17½
Edison Electric Ill., New York	100	114½	115
" " " 1sts	..	115	115½
*Edison Electric Ill., Brooklyn	100	105	108
" " " Boston	100	140	160
" " " Chicago	100	220	230
" " " Philadelphia	100	135	145
Edison Electric Light of Europe	..	2	6
" Bonds	..	80	85
" Ore Milling	..	5	12
Fort Wayne Electric	..	121½	123¾
General Electric Company	100	73	73½
" " deb. 5s	..	89¾	90
Interior Conduit and Ins. Co	100	55	60
Mount Morris Electric	..	..	65
Westinghouse Consolidated	50	..	32
" " pfd	50	..	47

*Ex Div.

WESTINGHOUSE ANNUAL REPORT.

The annual report of the board of directors to the stockholders of the Westinghouse Electric and Manufacturing Company, signed by President George Westinghouse, Jr., and dated May 17, 1893, is as follows:

Your Board presents herewith its financial statement for the year ending March 31, 1893.

It will be seen that there has been a profit from manufacturing of $1,491,817.13, and from other sources of $112,766 60, making a total for the year of $1,604,583.73. This is after charging to operating expenses the following amounts: $84.717.31 for alterations and additions to buildings; $155,484.87 for maintaining the machinery and tools in the highest order, and $58,188.86 for interest and discount.

The year began with large orders, but with only a moderate manufacturing capacity and a proportionate stock of material on hand, so that the above earnings were made under unfavorable circumstances due to the fact that the capacity of the works and the material in stock and in process had to be more than doubled during a steadily increasing press of business.

During the year the company has manufactured, and installed at the World's Fair in Chicago an electric lighting and power plant, consisting of twelve generators of 15.000 lights capacity each—two of 4,000 lights capacity each, one 750-h. p. generator, and several smaller ones. Six of the large generators are driven by engines having their shafts connected directly to those of the generators. This plant is the largest ever installed.

These generators mark a new era in electric light and power distribution. They are of the "two-phase" type, designed to drive Tesla motors, and at the same time to operate both arc and incandescent lamps; thus making the one form of generator useful for three purposes.

The total capacity of the plant exceeds the contract acquirements sufficiently to meet the demands that may be made by exhibitors for extra lights.

The company will also have at the Fair an extensive exhibit of its other forms of apparatus.

The stopper lamps now being manufactured in the company's Allegheny City works are being used exclusively in connection with the apparatus at the World's Fair. It is gratifying to be able to announce that in the manufacture of the Sawyer-Man stopper lamps all of the advantages anticipated have been fully realized. The low cost of manufacture, and the high efficiency of these lamps, together with the ability to renew their carbon burners, enable the company to sell lamps at lower prices than can be afforded by any other manufacturer. To meet the demand a new factory has been equipped with special machinery designed for the purpose, and already has a daily capacity of 5,000 lamps, which is being rapidly increased, and will be shortly quadrupled. The expenses incident to the establishment of this new lamp factory have been charged to the business of the past year. This branch will hereafter add materially to the volume and profit of the company's business.

The success of the stopper lamp, its low cost of manufacture, and the fact that it is the discovery, prior to Edison's patents, of inventors whose patents belong to our company, have turned a temporary check into a great business advantage.

Our competitors have copied our plans and infringed many of our patents, notably those relating to power transmission, and many important details essential to the successful operation of alternating current apparatus for the distribution of electricity for light and power purposes, for which we have brought suits for infringement.

The confidence expressed, in the last annual report, in the superior merit of the apparatus of the company, and in the strength and value of its patents, has been fully justified by the results of the year's operations; and we feel no apprehension as to the outcome of suits now pending or which may be brought by its competitors.

Your directors have been brought face to face with the fact that the business of the company has outgrown the present capacity of its factories, and that large savings could be effected if the manufacture were carried on in new works equipped with the latest devices for handling its product by machinery.

In view of the favorable result of the past year's business, and of the volume of orders in hand, and the future outlook, your directors have not hesitated to accept a proposition from the East Pittsburgh Improvement Company to sell to your company a site of 23 acres most favorably located with reference to railway facilities. The Improvement Company has agreed to erect on this site buildings and works according to the plans and under the supervision of the officers of your company, and to sell them to the company at their actual cost, not, however, to exceed $500,000 above the price of the land, and have agreed to take pay therefor in quarterly payments of $25,000 and interest, beginning Jan. 1, 1894. Your officers have estimated that the savings to be effected by the manufacture of its products in the new works will, on a most conservative basis, be more than double the amount of the quarterly payments. Thus, these new and complete works will be acquired without the expenditure of fresh capital, leaving the proceeds from the sale of the company's present property as working capital, without taking into account the manifold business advantages that will arise from the centralization of its manufacturing operations.

The results of the past year's business have shown that our apparatus can be sold for cash to responsible parties, and that the prevailing belief that long credits must be given, or that stocks and bonds must necessarily be taken in order to secure business, is not correct. Your officers and agents have found that low cash prices and good apparatus are sufficient inducements to secure all the trade the company can care for.

Although the profits of the business might have justified the payment of dividends on all of the stock of the company, the directors have thought it wise to pursue a very conservative policy, especially in view of the large expenditures required during the past year for machinery and material, and of similar expenditures which the present prosperous condition of the company's business may make necessary in the near future. Both the results and the prospects are so encouraging that the directors believe the stockholders will uphold them in a course which places the company in a position of undoubted financial strength, and which will assure the permanent continuance of dividends when once begun.

GEORGE WESTINGHOUSE, JR., President.

BALANCE SHEET, MARCH 31, 1893.

Assets.		
Cash in banks		$212.573.85
Bills receivable		66,228.47
Accounts receivable		2,289,982 70
Material in stock and in process of manufacture (at cost of labor and material)		1,414.662.31
Advances to leased companies		138.573.06
Bonds (par value $369,100)		358,197.15
Stocks (par value $6,469,257)		4,069.439.96
Real estate and buildings		453,937.98
Machinery and tools		710,0 3.61
Miscellaneous		60,055.54
Charters, franchises, patents, etc		4.378.031.69
Total assets		$14,450,806.32
Liabilities.		
Accounts payable		$569.630.48
Bills payable, issued for merchandise		576,003.64
Discounted with collateral		931,881.51
Contract and Contingent Liabilities.		
Scrip dividend		$194,562 00
Stock subscriptions		13,125.00
U. S. E. Ltg. Co.'s 6 per cent. 15 year bonds, $50,000 payable annually		600,000.00
(Bills receivable under discount, $182,054.19.)		
Capital Stock.		
Preferred, 73.378 shares	$3,668,940.50	
Assenting, 103,146 shares	5,157,.31.0)	
Common, 3,633 shares	181,650.00	
		9,007,921.50
(In Treasury, 6,621 shares preferred; 13,220 shares assenting.)		
Surplus.		
Balance, March 31, 1892		$1,880,445.20
Twelve month's net earnings from business	$1,491,817.13	
From other sources	112,765.60	1,604,583.73
		$3,485,028.93
Less amount written off in adjustment of matters pending in 1890 and 1891	$321,228.05	
Ditto in current year	98,839.65	$420,097.70
		$3,064,931.23
Interest on scrip	$39,000.00	
Interest on bonds	11,673.72	
Dividends	256,608.32	307,282.04
		2,757,649.19
		$14,450,806.32

AFFAIRS OF THE COMPANIES.

The Jenny Electric and Power Company, of Peoria, has increased its capital stock from $50,000 to $200,000 and changed its name to the Peoria General Electric Company.

The Grant Electric Motor Company, of Portland, Me., has been organized with the following officers, all of Boston: Mr. Abbott, president; Dr. Page, secretary; Elliot Grover, treasurer.

The Standard Electrical Company, of Detroit, has passed under the control of a syndicate of wealthy capitalists, who will vigorously push the manufacture and sale of the Standard storage battery. The capital stock has been raised to $2,000,000, and $20,000 worth of new machinery is being put in the Detroit works. Blocks are now lighted by this storage battery, it is stated, in St. Louis and Pueblo, Col., and three street cars on one St. Lous line and one on another are being constructed to be used with it.

The General Electric Company has, it is stated, orders unfilled for 2,500 railway motors and 127 railway generators, as against less than 2,000 motors and 90 generators at this time a year ago. The size of the generators has been so increased that the actual horse power ordered and undelivered to-day is 100 per cent. in excess of the unfilled orders a year ago. In the sale of this apparatus, aggregating about $3,000,000, there is no obligation, it is claimed to take one dollar of stocks or bonds in payment, 75 per cent. of the entire amount being for cash, and 25 per cent. for well secured notes.

NEW INCORPORATIONS.

The Electric Light Company, Ottawa, O., capital stock $30,000, has been organized to furnish electricity. A. V. Rice, N. E Matthews, C. H. Rice, N. Goetschius and M. P. Goetschius are interested.

The Kimball Electric Company, of Chicago, Ill., has been organized with a capital stock of $5,000,000 to construct railroads under the Kimball patent, which relates to an underground conduit system.

The Joplin City Light and Fuel Company, Joplin, Mo., capital stock $150,000, has been formed to deal in electricity, etc. C. H. Malin, H. A. Malin and A. B. Malin, all of Joplin, are the incorporators.

Canton General Electric Light Company, Canton, S. Dak., capital stock $25,000, has been formed to supply light, heat and power. J. F. Ferguson, O. S. Gifford and A. C. Milliman are the promoters.

The Mt. Vernon Electric Light Company, Mt. Vernon, Ill., capital stock $20,000, has been formed to supply electricity for lighting purposes. A. C. Tanner, G. W. Evans and W. L. Arnold are the promoters.

The Gallitzin Electric Light Company, Gallitzin, Pa., capital stock $20,000, has been formed to supply light to the public. J. L. Mitchell, A. A. Stevens and G. L. Owens, Tyrone, Pa., are the parties interested.

Economy Electric Company, Chicago, Ill., capital stock $1,500.000, has been formed to build and operate electrical machinery and appliances, etc. The organizers are G. A. Gage, A. C. Haven and C. E. Potter.

The Williams Bay Hotel Company, Chicago, Ill., capital stock $150.000, has been formed to manage and operate electric light plants, hotels, etc. M. E. Leclerque, F. E. Baker and L. H. Failey are the promoters.

The Martinsville Street Railway Company, Martinsville, Ind., capital stock $25,000, has been formed to erect and maintain an electric railway. H. A. Smock, H. W. Dryden, and E. F. Branch are the interested parties.

The Second Avenue Traction Company, Pittsburgh, Pa. capital stock $1,000,000, has been formed to construct and operate motors and cables for passenger railways. J. D. Callery, W. J. Burns and J. C. Reilly are the promoters.

The Des Moines Electric Company, Des Moines, Ia. capital stock $600,000, has been formed to establish and operate a water power plant. F. D. Goode, J. A. Colby, L. W. Goode and J. I. Biggs, Des Moines, are the promoters.

The Chicago Insulated Wire Company, Des Moines, Ia., capital stock $200,000, has been incorporated to make and sell electrical apparatus. W. A. Drake, F. F. Reed and Wm. M. Smith all of Des Moines, are the parties interested.

Electrical Fireworks and Construction Company, Chicago, Ill., capital stock $100,000, has been formed to manufacture and deal in electrical apparatus, machinery, etc. E. Giroux, A. Guillaume and E. E. Barrett are interested.

The Richmond Electric Light Company, Richmond, Mo., capital stock $18,000, has been formed to operate an electric light plant. The promoters are J. M. Ferguson, Burnett Hughes, John Gibson, C. J. Child and J. R. Hamacher.

The Abatis Electric Manufacturing Company, Chicago, Ill., capital stock $50,000, has been incorporated to manufacture and sell electric appliances, supplies, etc. A. R. Hussey, N. A. Erikson and Wm. Newman are the organizers.

The Bethlehem and Catasauqua Traction Company, Bethlehem, Pa., capital stock $60,000, has been formed to construct and operate an electric railway. J. K. Page, J. J. Coleman and W. J. Hartzell, Allentown, Pa., are interested.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-176 TIMES BUILDING, NEW YORK, May 15, 1893.

The Genett Air Brake Company has removed from 150 Broadway to 33 Wall street.

W. R. Ostrander & Co., 195-197 Fulton street, New York City, manufacturers of electric bells, annunciators, etc., have removed to 105 Fulton street.

Mr. Geo. Virtue, of Spinney, Virtue & Co., Lynn, Mass., manufacturers of rubber goods and insulating material, was in the city Thursday, calling on the trade.

The Jenney Electric Motor Company has recently opened an office at 39 Cortlandt street, New York City, under the management of Messrs. Rossiter, MacGovern & Co.

The Direct United States Cable Company has removed its Glasgow office from 40 Hope street to more commodious and convenient quarters at 4 Waterloo street, opposite the Corn Exchange.

Mr. W. C. Bryant, of the Bryant Electric Company, Bridgeport, Conn., was in New York on Thursday of last week. The Bryant Electric Company will shortly have several new specialties to offer the trade.

The Cutter Electrical and Manufacturing Company, 27 South Eleventh street, Philadelphia, Pa., has opened a New York office at 136 Liberty street, which will be in charge of Mr. Chas. D. Shain, who is well known in electrical circles.

Mr. A. D. Adams, the general manager of the Commercial Electric Company of Indianapolis, favored us with a call on Thursday last. Mr. Adams states that he is in the East for the purpose of securing a New York agency for the well known dynamos and motors of the Commercial Electric Company.

The New York Electrical Society will hold its 103d meeting on Wednesday, May 17, 1893, at 8:15 p. m., at Columbia College, Madison avenue and Forty-ninth street. Dr. Wm. J. Morton will deliver a lecture entitled "A Brief Glance at Electricity and Medicine." The lecture will be illustrated by experiments.

The Electrical Engineering Department of the Johns Hopkins University has been deprived of its instructor in mechanics of engineering, machine design and mechanical drawing by the resignation of Mr Francis Head, M. E., who is about to go into practical work. We understand that the position is still vacant.

The P. Claus Dynamo Company, of 550 and 552 West Thirty-sixth street, created quite a sensation in lower New York, Wednesday last, by the exhibition of two 110 volt, 300 ampere dynamos, mounted upon a truck, drawn by four horses, gayly bedecked with plumes. The dynamos were made for the abattoir of Messrs. Schwarzschild & Sulzberger.

Mr. John R. Cottman, of the Eureka Tempered Copper

Company, North East, Pa., has been in New York for several days. During a pleasant call at the office of THE ELECTRICAL WORLD Mr. Cottman reported no abatement in the increase of business his company has experienced since its start. Owing to great extensions of the works recently orders can now be filled promptly. Mr. Cottman says this is no joke.

The Commercial Cable Company has issued an interesting World's Fair pamphlet, in which is given a concise history of the Atlantic cable and the part which the Commercial Cable Company has taken in its development, including illustrations of the Great Eastern and a modern cable system, together with views of the various stations and offices of the Commercial Cable Company on both sides of the Atlantic.

The Brooklyn Institute, Department of Electricity, has elected officers for the year as follows: James Hamblet, president; Wm. S. Barston and J. P. Windringham, vice-presidents; Edward H. Lyon, secretary, and J. C. Reilly, treasurer. Roger S. White was substituted for W. A. Mosscrop in the Committee on Electric Lighting; Mr. Sinclair for R. N. Bayles in that on electromotors, and A. J. Watts, M. D., added to the Committee on Electro-Metallurgy.

The New York Insulated Wire Company, 13 Cortlandt street, New York City, has issued a World's Fair edition of its catalogue of Grimshaw and other wires, as well as of its vulca wire ducts. The little pamphlet is very neatly bound and printed on an extra quality of paper. It contains a view of the World's Fair grounds and a number of valuable tables and a collection of simple technical definitions and formulæ for non-professional people.

Mr. J. E. Ham, general agent for W. R. Brixey, manufacturer of Day's Kerite wires and cables, 203 Broadway, New York, has contracted to manufacture and lay for the Metropolitan Telephone and Telegraph Company two 18-conductor submarine cables similar to the nine previously furnished by him and now in service between New York and Jersey City. Mr. Brixey has returned from an extended visit to Chicago, where he has been looking after his exhibit, which is the first wire display in the Electricity Building to be completed.

Mr. Fremont Wilson, consulting electrician of the Suburban Underwriters' Association, has removed his office to the 11th floor of the Vanderbilt Building annex, Nassau and Beekman streets, New York City. The Suburban Underwriters' Association has recently made an extension of its territory by transferring from the middle department of Underwriters the following counties of New Jersey: Essex, Union, Middlesex, Bergen, Morris, Sussex, Passaic, Somerset, Warren and Hunterdon. This association has also adopted the revised and codified rules of the Underwriters' National Electric Association.

The Striking Linemen.—The strike of the Brooklyn linemen, in the employ of the New York & New Jersey Telephone Co., the Brooklyn City Railway Co., and the Citizens' Railway Co., which recently took place in Brooklyn, instead of approaching settlement seems to be extending in other directions. On May 8 the inspectors, linemen and climbers of the New York & New Jersey Telephone Co., Jersey City, went on a strike, demanding an increase of pay of 50 cents per day, and payment for all overtime work at the rate of time and a half. The inspectors received $2 per day and the linemen $2.50, which they demand increased to $2.50 and $3 respectively, claiming that this price is paid for similar work in other parts of the country for an eight hour day, while they are willing to work nine hours if their request is acceded to. The companies have thus far refused to yield to the demands of their employés and no settlement has been reached. Several attempts have been made to adjust the difficulty by arbitration, but this, too, has as yet had no results.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., May 13, 1893.

The Bryant Electric Company, Bridgeport, Conn., is about to introduce an entirely new line of goods. It has one of the finest electrical manufacturing plants in New England, the works covering an acre of ground space.

The Bradbury-Stone Storage Battery Company, Lowell, Mass., since it started in business has been very successful. Its battery has won an enviable reputation, and the company finds it necessary to enlarge its present quarters in order to meet the increased business.

O'Neill, Heymann & Co., 358 Atlantic Avenue, Boston, Mass., have just started in business as electrical contractors. The members of this firm are all well known in the electrical fraternity. Their specialties are the O'Neill patent pole pin, and the Monarch arc lamp. They will also do a general construction business.

Mr. George H Almon read a paper last Monday evening before the Massachusetts Mechanical and Electrical Association, taking for his subject "Atmospheric Electricity," explaining its action on all kinds of overhead circuits, and also giving a detailed explanation of the different kinds of lighting arresters, and their application to electric light lines. The paper was much appreciated.

The Redding Electric Company, 41 Federal street, Boston, Mass., has issued a catalogue illustrating and describing the specialties for which this firm has become so favorably known. A colored plate shows many handsome designs in china of Iona switches, and quite a number of other designs of switches are shown for flush work. We also note the Iona hand lighting burner which introduced such a notable improvement in gas lighting apparatus.

Mr. Walter B. Snow read a paper before the Society of Arts, Massachusetts Institute of Technology, last Thursday on the blower system of heating and ventilation. On account of Mr. Snow's thorough knowledge of this subject, the paper was much appreciated, as it treated the practical as well as the theoretical side of the question, and with this particular subject there are probably few men in the country who are better informed than Mr. Snow.

The Frisbie Elevator and Manufacturing Company, New Haven, Conn., has succeeded to the business of the old D. Frisbee Company. The new company has bought the adjoining property, and will start at once to erect additional buildings, as the old works are not large enough to comply with the demands. The "Frisbee" constant speed direct connected elevator is the company's latest production. The regulation of this machine is claimed to be absolutely perfect. One of them is in practical operation at the Chicago Fair, being used to convey passengers to the exhibit of Messrs. Wallace & Son, who are making an extensive display. Mr. Fletcher, of Dayton, O., who is extensively known in electrical circles, is treasurer of the company.

The Campbell Electrical Supply Company, Boston, Mass., has just issued its latest catalogue and price list. This is a very complete book of 35 pages, giving a short history of Century insulation, resistances of copper wire, dimensions of bare copper wire, differences between wire gauges, equivalents of wires, B. & S. gauge and iron wire gauge, etc. This company has also in connection with its works a re-covering department. They state in this connection: "By our re-covering process we take your old wire, repair and reinsulate it with our Century insulation, thus giving you a wire at a nominal cost thoroughly insulated and better than when new." They have received many letters speaking of the Century insulating tape in the highest terms. This company also handles the Diamond transformer and the Shaw radial car truck.

WASHINGTON NOTES.

WASHINGTON, D. C., May 13, 1893.

The Love Underground Trolley System.—During the past winter the Love Electric Traction Company, of Chicago, have installed about two and one-half miles of their system in this city, and which is known as the U street extension of the Rock Creek Railway. The first cars were run over the line on March 3, since which time the road has been in continuous operation, and there has been scarcely anything to mar its success. That the system is a success is best shown by the fact that the Rock Creek Company has accepted the road, and a letter received from Mr. H. Claude, the superintendent of that company, is as follows: "Love Electric Traction Company, Chicago, Ill. Gentlemen: Connecting with our overhead trolley line, extending from Eighteenth street and boundary in the city of Washington, six and one-half miles to Chevy Chase, we have had constructed within the city limits, along U street, from Eighteenth to Seventh, a double track line on the Love conduit plan. The construction of this conduit line was commenced on Dec. 10, 1892, and on March 3 cars were running from Eighteenth to Fourteenth streets. The line was completed to Seventh street April 15, and the whole road was immediately put in operation, and has been operated continuously since, and, so far, this system seems to be quite as successful as with the wires overhead. At Fourteenth street a double track cable road is crossed without difficulty. At Eighteenth and boundary the trolleys are changed, the underground trolley being dropped, so that the same cars run on the two systems, the time required for the change being but a few seconds. This change is made at the end of a sharp curve and on a heavy grade. The only apparent difference so far in the running of the cars on the two systems is that there seems to be less resistance, and therefore less power required, on the underground than on the overhead." A description of this road was given in THE ELECTRICAL WORLD of Jan. 14, 1893.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
936 MONADNOCK BUILDING, CHICAGO, May 13, 1893.

A bill was introduced into the Illinois Legislature on May 9 to give city councils and the boards of trustees of cities and villages the right to levy taxes for certain corporate purposes. It is designed to enable Chicago to purchase the World's Fair electric plant and appliances.

Among the exhibits completely installed on the opening day of the World's Fair were those of H. T. Paiste, 10 South Eighteenth street, Philadelphia; the Chicago Electric Wire Company, of Wilmington, Del.; W. R. Brixey, 203 Broadway, New York City, and the Reliance Gauge Company, Cleveland, O.

A Physical Impossibility.—On account of the backward condition of the exhibits in the Electrical Department of the World's Fair, a special notice was recently issued by the chief of that department stating that May 14 had been fixed as the extreme limit of time for receiving and completing the installation of exhibits, and that all exhibits not absolutely complete on that date would remain during the Exposition in an unfinished state.

The Electric Appliance Company, of Chicago, announces that the new Whitney ammeters and voltmeters for alternating current work are now ready for the market. It is claimed that the difficulty hitherto experienced with alternating current instruments, caused by varying frequencies, which has made it necessary to calibrate each instrument to the machine on which it was to be used, has been overcome, and that an instrument has been produced which can be placed on any circuit without calibration and give absolutely correct readings.

Taylor, Goodhue & Ames have received the best proof that their move from 827 Monadnock Block to No. 348 Dearborn street was a wise one by the increased number of orders that they are receiving from city customers. The demand for the Wagner direct current fan motor continues very large, and it is reported that these motors are giving the best satisfaction. There are many of them already introduced throughout the down town districts, where artificial breezes are the only kind that are obtained. The demand from out of town for alternating motors, both for power and fan work, continues to be very satisfactory. They expect that much interest will be excited among World's Fair visitors by the exhibit of their alternating current power motor. Two of these will be installed in their exhibit in Electricity Building, one 2-h. p. coupled direct to an exhaust fan, and one 10-h. p., which will operate a direct current generator. These motors are single-phase, no special circuit being required for their operation, and visitors will now see it proved conclusively that lights on the same circuit are not affected by this type of motor.

News of the Week.

THE ELECTRIC LIGHT.

Newton, Mass., is to establish an electric light plant.

Kingston, N. Y., is discussing the question of bonding the village to purchase a town lighting plant.

Chester, Pa.—Ground will soon be broken for the large addition to the plant of the Chester Electric Lighting Company.

The Hillsdale (Mich.) Council has voted to issue bonds to establish an electric plant for municipal and commercial lighting.

The Priceburg Electric Company, of Priceburg, Lackawanna county, Pa., has been organized to supply the borough with street lights.

Weston, Ore.—Weston expects to complete the electric light system during the present year and have it in running order not later than Oct. 1.

Brooklyn, N. Y.—The *Chronicle* states that residents of Union Course, a suburb on the road to Bath Beach, are forming an electric light company.

Cincinnati, O.—The proposed new Sixth street market house will be lighted by electricity. City Electrician Cabot has specifications under consideration.

Girard College, Philadelphia, Pa., is to have a complete electric lighting plant for the lighting of the building and grounds. An appropriation of $75,000 has been made for this purpose.

Ludlow, Ky.—The City Clerk has been authorized to advertise for bids to light the city by electricity. A local company has been organized by J. J. Weaver and others to attempt to carry out the contract.

The Waupun (Wis.) Council has voted to grant a franchise to the Waupun Electric Light Company, and also voted to accept a contract for 80 32-c. p. incandescent lights for street lighting, the lights to run from dusk until 12 o'clock

The West Duluth, Minn., Electric Light Company has consolidated with the Hartman General Electric Company, of Duluth, under the name of the latter company, and will put in at once an incandescent circuit for Oneota.

Batavia, N. Y.—At a meeting of the village trustees the board appointed a committee of two men to investigate into the matter of a municipal electric lighting plant and report on same. It is proposed to bond the village in the sum of $25,000 for this purpose.

THE ELECTRIC RAILWAY.

Canfield, O., has granted a charter for an electric railway.

Clarkesville, Tenn.—The substitution of electricity for mules on street railways is being discussed.

Massillon, O., has granted a franchise for an electric road between Massillon and Navarre, five miles away.

Hoopeston, Ill.—The Hoopeston Railway Company, capital $40,000, has been formed to build a street railway.

Warren and Sharon, Pa., capitalists are securing rights of way for an electric road to connect the two towns.

Camden, N. J.—At a meeting recently held here, $400,000 was subscribed for an electric road from Camden to Trenton.

The Columbia & Donegal (Pa.) Electric Railway has contracted for Westinghouse apparatus and will be opened June 15.

The Milwaukee & Wauwatosa Motor Railway Company is to equip its line with electricity as soon as it can be done.

Findlay, Van Buren and Fostoria, O., are to be connected by an electrical railway, the survey for which has been finished.

The East End & Sharpsburg Electric Railway Company has been chartered and will build a line from Pittsburgh to Sharpsburg.

The Union Railroad Company, of Providence, R. I., proposes, it is said, to abandon a large portion of its cable line in favor of the trolley.

Brooklyn, N. Y.—Work has been commenced on the Myrtle Avenue line of the Brooklyn City Railroad to equip it with the trolley system.

Iowa City, Ia.—The subscription from citizens to insure an electric street railway is rapidly nearing completion. Only $2,000 are now needed.

Wabash, Ind.—Preliminary steps have been taken for the organization of a street railway company, capital $100,000. James McCree heads the directory.

Clinton, Mass.—The Clinton Street Railway Company has been fully organized, and work will immediately be begun and the road completed in three months.

Stowe, Vt.—The town has voted to raise $10,000 toward building an electric road from Stowe to Waterbury. E. D. Blackwell, of Montpelier, Vt., is leader in the movement.

The Buffalo (N. Y.), Tonawanda & Sanborn Electric Railroad is incorporated and will run through St. Johnsburg, and near the village of Bergholtz, to Sanborn.

Hoosick Falls, N. Y.—The Hoosick Falls Electric Light and Power Company, C. B. Story, manager, is to build an electric road to North Hoosick and Walloomsac.

Jersey City, N. J.—The Consolidated Street Railroad, which has obtained control of all the railways there and in Newark and vicinity, has issued $8,000,000 of bonds to be used in equipping the entire system with electric power.

Columbus, Ga.—The North Highland Street Railway Company has petitioned for right of way over seven miles of streets. A power-house will be erected to furnish power for the company and light for the streets of the city. A. S. Carter is president.

The Philadelphia & Allentown Electric Railway Company expects to begin active operations on the construction of the road at once. All rights of way between Allentown and Doylestown have been secured and contracts let for the building of the road.

The Columbia & Donegal Railway Company, of Columbia, Pa., and the Columbian Traction Company have decided to build an electric railway themselves, instead of giving it to contractors. E. N. Smith is engineer and Blake A. Mapledrom is mechanical superintendent. Frank Given is superintendent. Work will begin at once

White Plains, N. Y.—Hon. Samuel C. Conover, of White Plains, has purchased the franchise of the Tarrytown, White Plains & Port Chester Electric Railway, and work will be commenced this summer. The road will now be called the Ellensford, White Plains & Mamaroneck Railway. S. W. Parker, of Mamaroneck, and J. H. Moran, of White Plains, are also interested.

The Philadelphia & Harrisburg Electric Railway Company.—Charters, right of way and connecting electric railways and franchises have finally been secured for the entire line between Harrisburg and Philadelphia, and the system will soon be operated by a general company that will be called the Pennsylvania Traction Company. A site for a station has been secured at Coatesville, in which there will be a 7,500-h. p. generator, and the carshed will be 450 feet in length by 250 feet in width. The estimated cost of the road with rolling stock is $5,000,000.

LEGAL NOTES

A decision was filed May 10 by Judge Core, of the United States Circuit Court, denying the right of the Edison company to enter suit against the Equitable Life Insurance Company for using other than Edison lamps.

Tax on Poles.—By a recent decision of the United States Supreme Court, cities and boroughs in the United States, it is claimed, have authority to enact an ordinance laying a tax upon all telegraph, telephone and electric light poles occupying their streets and alleys. A number of cities and boroughs are enacting ordinances in conformity with this decision.

The American Bell Telephone Company filed a bill in the United States Circuit Court at Pittsburgh recently against the McKeesport Telephone Company for an alleged infringement of a patent dated Jan. 30, 1887, numbered 186,787, for an improvement in electric telephone. The plaintiffs ask for a preliminary injunction. This is the first move in a case which is destined to arouse the interest of leading corporations of the United States. It will be remembered that a month or more ago the Bell patents were said to have expired.

Immediately Eastern capitalists formed a company and about two weeks ago began operations in McKeesport as a starter.

Suit Over the Trolley.—United States Marshal Loveridge, of New Haven, has served the first papers in a suit which, if won by the plaintiff, the Thomson-Houston Electric Company, will result in the sudden closing of the Winchester Avenue & West Haven Electric road in New Haven. The suit is brought against these roads by the Thomson-Houston Electric company to restrain them from using the overhead trolley system. Bettz, Atterbury, Hyde & Betts, of 120 Broadway, the attorneys for the plaintiff, said: "We bring this suit in perfect good faith, and we shall push it vigorously to the very end, and we have very great hopes of being able to sustain the patents." The defendants have the usual month prescribed by law in which to file their answer, and the usual course of pleading would be gone through with.

Storage Battery Litigation.—An important electrical suit was put on a hearing in the United States Circuit Court at Boston, on May 9, before Judge Colt. The complainants were the Brush Electric Company and the Consolidated Electric Storage Company. The respondents were the Milford & Hopedale Street Railway Company, the Hopedale Electric Company, William S. Hall and Edward P. Usher. The complainants allege that the respondents have infringed their patent on storage batteries, and they ask the court for an injunction. Their allegations are denied by the respondents. The patent in question, which the complainants claim has been infringed, was the work of Charles F. Brush. Afterward the Brush company conveyed to the Consolidated concern the exclusive right to make and sell the batteries. Messrs. Witten & Kenyon, Bentley & Blodgett and Charles E. Mitchell are the counsel for the complainants. William B. H. Dowse, Louis D. Brandeis and William S. Hall represent the respondents.

Incandescent Lamp Litigation.—At the session of the Supreme Court of the United States last week a petition was presented asking the court to bring up for review and determination the case of the Edison Electric Light Company *et al.* against the Sawyer-Man Electric Company, now pending in the Circuit Court for the Southern District of New York. In support of the petition an additional brief was filed by B. H. Bristow, which presents the arguments for the granting of the petition. In the court below the Edison company sued for an injunction against the Sawyer-Man company to prohibit it from manufacturing a lamp said to be an infringement of the patent granted to Edison in January, 1880, which had been held to be valid in another proceeding. Counsel for the Sawyer-Man company contend that the injunction sought ought not to be issued, for two reasons. First—That the Edison company has been guilty of laches. Although the patent was issued in January, 1880, no action was taken to prevent its infringement until May 1885. During all that time competitors of the Edison were engaged in the business of furnishing electric light plants without objection, and stockholders of these and other companies were thereby induced to invest their money in similar enterprises. All this investment, estimated at $25,000,000, counsel say is at stake, and they urge that the court ought not to permit the Edison company, after sleeping on its rights these five years, to reap the benefit of the pioneer work done by its competitors, the result of which has been to make the business remunerative. Second—That the Edison company is a part of a combination the very existence of which is unlawful. Its purpose is to create and maintain a monopoly of the electric lighting business, and it cannot therefore have the aid of the court in carrying out the illegal purposes of its organization

PERSONAL NOTES.

Mr. M. R. Hults, manager of the Western Union Telegraph Company, of Bridgeport, Conn., gave a dinner there on Saturday, May 13, to a large number of gentlemen, mostly connected with the Western Union Telegraph Company, forty of whom were from New York City.

Mr. Gisbert Kapp sailed for Boston on the 11th inst. on the Cephalonia. He is coming to this country partly for pleasure and partly on business. He is very well known here from his frequent contributions to electrical literature and will receive a hearty welcome.

Mr. Frank G. Mason, superintendent of the Brooklyn Bureau of Police, has been appointed First Honorary Assistant of the Bureau of Electricity at the World's Fair. He will have as associates Mr. Elliot Smute, superintendent of fire alarms in New York City, and Morris Mead, city electrician of Pittsburgh.

M. E. Hospitalier, of Paris, the editor-in-chief of *L'Industrie Electrique*, will arrive in America the beginning of July to visit the World's Fair and attend the Congress of Electricians. The name of M. Hospitalier is so well known in America that he needs no introduction to the electrical public, by whom he will be received with the appreciation his eminent professional standing merits, and with a cordiality that will be quickened by his well known geniality.

Prof. Mascart, of Paris, has been appointed as a member of the International jury for the World's Fair for the section of Electricity, representing his country, France. Prof. Mascart is well known to electricians; he is one of the authors of the largest work on electricity and magnetism published in the French language, and is well known for his researches in electrical science. He was a member of the jury of the Paris Exposition of 1889 in the class Electricity.

Sir James Anderson died at his residence at Queen's Gate, London, on the 7th inst. He was born at Dumfries in 1824, and in 1840 joined the merchant marine and after commanding a sailing vessel to India and China entered the service of the Cunard company in 1851. He was selected for commanding the "Great Eastern" for the Atlantic cable expedition. In 1865 the cable was lost in mid-ocean, but the next year it was successfully laid and the old cable brought up from a depth of two miles and the work completed. For the part he took in this enterprise he received the honor of knighthood. He was connected with most of the principal English cable companies as a director or in some other capacity. At the funeral, which occurred on Tuesday the 9th, at St. Philip's Church, there were present Sir John Pender and the Marquis of Tweeddale, representing the Associated Telegraph Companies, and a piece of the original cable of 1866 was attached to the coffin.

Mr. A. W. Meston, superintendent of the Emerson Electrical Manufacturing Company, St. Louis, Mo., died of consumption at his home Friday night, May 12, after a lingering illness of several months. He had recently returned from a trip to Jamaica taken with a view of benefiting his health. Mr. Meston was born near Edinburgh, Scotland, 26 years ago, and came to this country at the age of 14. During the past eight years he had lived in St. Louis, during which time he took a short course in electrical engineering at Washington University. In 1890 he left the University and engaged in the manufacture of electrical apparatus in a small way, in which venture he was associated with his brother, Charles R., Meston. This resulted in the organization of the Emerson Electric Manufacturing Company in October, 1891, of which he became superintendent and engineer. Mr. Meston was a deep student in electrical matters. His special study was that of alternating current motors. His work in this field will undoubtedly be recognized as it resulted in one of the first successful alternating current motors.

MISCELLANEOUS NOTES.

Mr. Frank B. Rae, of Detroit, has been retained by the town of Hillsdale, Mich., as electrical engineer to superintend the construction of a town plant.

The Niagara Falls Power Company, through an amendment to its charter, passed by the last legislature, has secured the right to furnish power throughout New York State.

To Try the Bicycle Road.—F. W. Dunton, president of the Long Island Boynton Bicycle Railroad, is arranging for the first trip over the completed portion of the road, which is to run from Bellport, on the South Shore, to Rocky Point, on Long Island Sound. The date is not definitely set, but it will probably be the first week in June.

A Dangerous Rival.—The New York Central's new Columbian engine No. 999, attached to the Empire State Express on Tuesday, May 9, covered a mile between Grimesville and the Forks in 35 seconds, breaking all previous records; this was at the rate of 102 miles an hour. On May 11, between Rochester and Buffalo, the same engine covered a mile in 32 seconds, which was equivalent to 112½ miles an hour, which is by far the highest speed that has ever been attained.

The Thomson Electric Welding Company has recently built at Lynn a welding machine for the Johnson company, Johnstown, Pa., for the purpose of welding steel rails. A number of successful experiments have been made by the Johnson company, and the process will be tried on the West End Street Railway in the course of a few weeks. By this process two rails can be welded together in from five to seven minutes while the rails are in place on the track, and thus a practically single rail of 800 to 1,000 feet can be obtained, and a loss of power by short circuiting and injury to underground wires is obviated, the rails making a good return circuit.

Rochester To Be Supplied with Power from the Falls.—Rochester, as well as Buffalo, is to have the benefit of the Niagara Falls electric power. A contract has been made with the Cataract Electric Company of Rochester by which the former is to furnish the latter any part of 25,000 h. p. of the electric energy, as soon as the transmission line can be laid from Niagara Falls to Rochester. The Niagara Falls Power Company will go beyond Rochester and supply Syracuse, Utica, Rome, Schenectady, Albany and New York. A syndicate has been formed in New York City, with a capital of $5,000,000, for the construction of a line between Niagara Falls and Albany for the transmission of electric power, and the cities along its proposed line can be supplied with electricity for light, heat and power.

A Large Multiphase Plant.—Work has been begun on a transmission plant to transmit electrically 1,000 h. p. from Lowell to Grand Rapids, Mich., at a loss of less than 25 per cent. The distance is nearly 20 miles. Very few transmissions at as great distance and as high efficiency have ever been installed. It is proposed to place in direct connection with the water wheels in Lowell a 1,000-h. p. multiphase dynamo that generates a current of low voltage. By means of a transformer the current will be increased to a voltage of 20 times the pressure. In Grand Rapids a second transformer will reduce the current to a voltage desirable for the use for which it is intended. The General Electric Company will furnish the apparatus to the West Michigan Electric Company, which will operate through the Grand Rapids Electric Company.

Trade and Industrial Notes.

The Dewey Electric Heating Company has removed its office from Syracuse, N. Y., to Boston, Mass.

The Gisholt Machine Company, Madison, Wis., has sent out a catalogue containing information and numerous illustrations in regard to its turret lathes and the excellent work they do.

The Onondaga Dynamo Company. of Syracuse, N. Y., has contracted with O. F. Heath, of Northville, N. Y., to furnish an electric light plant. Six hundred incandescent and 25 arc lights will be furnished. The service will commence June 1.

The Backus Water Motor Company, Newark, N. J., has not changed its name to the Backus Manufacturing Company, as was erroneously stated in these columns last week. The latter company has been a distinct corporation for several years.

The North Shore Traction Company, of Salem, Mass., has received 16 carloads of material for its new boiler plant. The boilers are of the National Water Tube type. manufactured by the National Water Tube Boiler Company, of New Brunswick, N. J.

Chas. A. Schieren & Co., of 47 Ferry street, New York, will be one of the best represented firms at the World's Fair. Besides their personal exhibit, there are no less than 64 of their belts in use in different parts of the exhibition, some of which are 72 inches wide.

A. O. Schoonmaker, 158 William street, New York City, a large importer of East India mica, claims that mica in the solid sheet is far superior in insulating qualities to the manufactured forms and he is able to furnish it in sheets uncut, cut to size, or cut to any pattern.

The Electrical Piano and Motor Company, 84-88 Mechanic street, Newark, N. J., has issued a little folder describing the Feldkamp electromagnetic fan, which it manufactures, and which is claimed to be highly efficient and economical. In preparation for the hot season the company now has a stock on hand.

F. R. Chinnock, of the New York office of the Ball Engine Company, Erie, Pa., has taken an order for a 125-h. p. engine from the Far Rockaway Electric Light Company, Far Rockaway, Long Island. The Brockton Street Railway Company, Brockton, Mass., has also ordered a second 600-h. p. cross compound engine from the Ball Engine Company.

J. Grant High, successor to High & Miller, dealers in second hand dynamos and motors, 123 No. Third street, Philadelphia, in addition to his extensive second hand business is now manufacturing single and double pole knife switches. The prospects of the latter augur well for a great demand. The workmanship on these switches is first class.

The Commercial Electric Company, Indianapolis, Ind., in a new catalogue which it has recently issued describes the well known motors and dynamos manufactured by it. The field magnets of these machines are all forged, which is contrary to the usual practice in this country and which is claimed to be an important practical advantage.

Messrs. Rossiter, MacGovern & Co., 39 Cortlandt street, have made arrangements with the Jenney Electric Motor Company, of Indianapolis, to represent them in the Eastern part of New York State and New Jersey. There is no doubt but that under the management of this firm the Jenney motor and dynamo will at once take the prominent position in the market to which it is entitled.

The Utica Electrical Manufacturing and Supply Company, 10 Cornelia street, Utica, N. Y., has received a flattering testimonial from the assistant electrical engineer of the Electrical Department of the World's Fair, stating that the result of a thorough test given to the sample Hercules No. 1 arc light cut-out, was very satisfactory. The switch was tested first by cutting in 40 lamps, then 50 and finally 70.

"Some Features of the World's Columbian Exposition" is the title of an attractive little book issued by Queen & Co., Incorporated, Philadelphia, Pa., which is devoted to a description of the World's Fair grounds, points as to when and how to see the Exposition, and a detailed statement of Queen & Co.'s exhibits, which number five in all, one in the Electricity Building and four in the Liberal Arts Building.

The Emerson Electric Manufacturing Company, 1108 St. Charles street, St. Louis, Mo., in a recent catalogue describes the Meston alternating current motor with illustrations and descriptions of the many applications to which it has been adapted. This motor is intended for use on ordinary single-phase circuits, and we note particularly that one of the applications has been neatly adapted for dental work.

The E. G. Bernard Company, of Troy, N. Y., has removed from its old quarters, in the Hall Building, 7 First street, to 43 Fourth street, its growing business having made this change necessary. Its new office and salesroom are much larger and more suitably located, and now adjoin the finely appointed workshop which this enterprising firm has equipped for repair work and the manufacture of its various specialties.

O. D. Pierce & Co., manufacturers and dealers in electrical supplies, 806 Walnut street, Philadelphia, Pa., have issued a complete catalogue of all the various supplies handled by them. They are the agents for the Perkins Electric Lamp Company, Perkins Electric Switch Company, The Dayton Fan and Motor Company, and the W. S. Hill Electric Company, and control a large variety of well known and standard apparatus.

The American Silk Manufacturing Company, No. 311 Walnut street, Philadelphia, has met with remarkable success in the manufacture and sale of its silk-waste machine wipers, considering the fact that they had been established in St. Louis for some years before removal. Users of these towels are now found in the railroad and machine shops throughout the East and among all the leading manufacturing establishments in Philadelphia and the West.

The Ansonia Electric Company, formerly the Electrical Supply Company, of Chicago, has closed a contract in Iowa for Helios arc lamps, to be used in street and commercial lighting, has secured a 30-ton order for the well known P. & B. line wire, and has also added to its list of contracts for overhead equipment the road, 13 miles in length, running between Goshen and Elkhart, Ind. The company states that the New Sunbeam lamp is meeting with as much favor as the old Sunbeam.

George J. Altham, of the Altham Motor Company, Boston, Mass., has recently received patents from the United States, Great Britain, France, Italy, Belgium, Norway, Sweden, Austria, Hungary, Spain and colonies, Canada, New South Wales, Victoria and Queensland on "The Art of Obtaining Motive Power," "Improvements in Motors" and "Turbines." A new series of patents is now in process, protecting valuable devices, which will be used on the new street car motor, and for mechanical purposes generally.

The Berlin Iron Bridge Company, of East Berlin, Conn., has issued a sumptuous and handsomely bound catalogue of 317 8-in. × 11-in. pages, containing over 150 views of structures erected by them. Taken in connection with the accompanying reading matter the prospective builder would find little use for an architect to enable him to settle on a suitable design. Many of the designs of central stations and a large number of the most important industrial buildings erected in America are included.

W. A. Vail, 136 Liberty street, reports that he has never experienced a better season than this one in storage batteries, Walker ammeters and the swinging ball lightning arrester. He has recently installed storage battery plants on the yachts Tillie and Alicia and Austin Corbin's car Manhattan, all during the month of April, and the prospective contracts for the month of May and recent sales indicate that it will be a most prosperous month. Over 200 swinging ball lightning arresters were sold during the month of April.

Mr. L. C. T. Wade, formerly with the General Fixture Company, New York, manufacturers of electric combination and gas fixtures, has opened a general fixture department in connection with the business of Stern & Silverman, 707 Arch street, Philadelphia. Mr. Wade is well known in the electrical field, and it is his intention to make his new department second to none in the line of general electrical combination and gas fixtures. Stern & Silverman are sole agents for the line of fixtures manufactured by the General Fixture Company.

Clayton & Lambert, Ypsilanti, Mich., have now recovered from the damage recently done by the cyclone. They were obliged to tear down about all that was left of their factory, but have placed their works in excellent shape again, having greatly improved their burner by providing it with a stuffing box at the back of the needle and making the needle a quick opening and closing valve and furnishing it with a guide and check. This improvement, which involved considerable additional expense, makes it impossible for the terminal to leak at the needle point, and makes the valve work much easier.

The Stirling Company, manufacturer of water tube boilers, 73 Cortlandt street, New York City, has recently received the following orders: Cleveland (O.) Cable Railway Company, 750 h. p.; Lehigh Valley Traction Company, 900 h. p.; Whitman & Barnes, for their new Chicago works, 1,000 h. p.; Elmira Knitting Mills, 50 h. p. Also a large plant for the Union Passenger Railway Company, New York City, and for the Lindell Avenue Railroad, of St. Louis, Mo., the latter plant being of 2,600-h. p. capacity. The New York office of the Stirling Company will in future be in charge of Mr. Fred. L. Schifflin, general sales agent.

The Armington & Sims Engine Company, of Providence, R. I., has issued a handsome catalogue devoted to its well known high-speed engine, which is a model of artistic catalogue making. The artistic designs on the front and back covers give the pamphlet the appearance of one of our high class monthly magazines, and the paper and press work of the reading pages are in keeping. The frontispiece is an etching of the Jumbo Edison steam dynamo, directly connected with the first Armington & Sims high-speed engine. The technical information relating to the engine will be found of general interest by the inquirer.

The Eureka Tempered Copper Company, of North East, Pa., recently furnished the Westinghouse Electric and Manufacturing Company the parts of a commutator for an aluminium reduction dynamo, each segment of which weighs 80 pounds. These segments are believed to be the largest ever made by any company.

The works at North East have recently been greatly enlarged, a new building 100 feet by 40 feet having been erected and the capacity of the machine shop doubled. Notable improvements have also been made in methods of manufacture, and with 40 additional moulders it is believed that orders can now be delivered promptly. The exhibit for the World's Fair has been completed and is said to be unique in its line.

The Wells & Coutan Company, Limited, of 29 and 31 Gold street, New York, has recently started in business as dealers in standard gauges and other steam goods. Messrs. O Chan Wells and Charles A. Coutan formerly represented the Crosby Steam Gauge Company in New York, and Mr. Jos. R. Gordon, the superintendent, was formerly connected with the same firm in Boston, and more recently was in charge of the instrument branch of the steam engineering department of the New York Navy Yard. With the unusual business and technical qualifications these gentlemen possess there is no doubt but that their neat trade mark will soon become well known throughout the United States as a certificate of reliability.

The Philadelphia Engineering Works, Limited, Philadelphia, Pa., have contracted with the Poughkeepsie Iron Company for a complete blast furnace plant at Poughkeepsie, N.Y. The plant will be equipped with three 19 × 60 inches Gordon, Whitwell-Cowper firebrick hot blast stoves, three Corliss valve horizontal blowing engines, 84 inches diameter of blast cylinder, 50 inches diameter of steam cylinder, 72 inch stroke, of their latest patterns and designs; 1,200 h. p. of Stirling water tube boilers, and all the pumps and piping necessary for the plant. The whole work will require about one million firebrick, the orders for which have been placed with Mr. C. N. Christie, of Poughkeepsie, N. Y., and Mr. John B. Marie, of Philadelphia, Pa. The plant is to be completed and ready for operation the latter part of October.

The Brown & Sharpe Manufacturing Company, of Providence, R. I., has sent us two catalogues, one being the 1893 revised edition of the trade catalogue and price list of their famous line of machinery, workshop standards, gears, etc., etc., and the other a beautiful brochure for World's Fair visitors. The catalogue has been thoroughly revised and rewritten and contains 306 pages—58 more than the preceding one. The new matter, which is considerable, and the changes in the old make it specially desirable that this should replace former editions. The other pamphlet referred to gives a brief description of their works and business and offers some suggestions of use to those traveling in America for the first time and extends an invitation to visit their shops and exhibits. Its handsome pages contain a number of artistic head and tail pieces and other illustrations printed on a special quality of paper. The suggestions in regard to living, traveling, etc, in America will be useful to other than foreigners, as well as the historical facts regarding Providence, Rhode Island and Chicago. A folder gives a view of the World's Fair grounds, and there is a general view of Chicago as well as one of its central business portions, and much other matter of use to both the traveler and the stay-at-home.

H. Ward Leonard & Co., 136 Liberty street, New York City, have met with flattering success in the line of bulk electric contracting work, even in the general dullness of business during the past year. The business of the company during its first year, that is, 1891 to 1892, amounted to $530,000, and it is claimed to be rapidly increasing. Since the first of January the capital of the company has been doubled, the fully paid-up capital now being $120,000. The company has no agencies or affiliations with any manufacturing companies and uses apparatus made by all the first-class manufacturers. Among the important contracts now under construction by this company are the following: Cavadutta Electric Railway, bulk contract for complete railway 17½ miles long, joining Gloversville, Johnstown and Fonda, New York State; Broadway Power House, bulk contract for steam and electric plant for 5,000 lights; Betz Building, Philadelphia, bulk contract for steam and electric plant for 4,000 lights; Broadway Cable Road, Fiftieth street power station, bulk contract, steam and electric plant for 424 incandescent and 22 arc lights; Scott & Bowne Building, bulk electric contract for 1,500 lights; Cammeyer Building, 3,100 lights; Puck Building, 1,000 lights; New Netherlands Hotel, ventilating fans, motors, etc.; New York, New Haven & Hartford Railroad Building, 1,500 lights; Hawthorne Apartments, 300 lights; Home Life Insurance Company, 1,900 lights, dynamos and engines; Church Mission House, 900 lights; Johnson Building, wiring for 70 arc lamps; Princeton Inn, tubing for 232 outlets; Decker Building, 1,200 lights.

Business Notices.

Transformers rewound and repaired. Write for prices. The Hill Manufacturing Company, Salem, Va.

Oil Filters for sale cheap. Prices on application to Purity Oil Filter Manufacturing Company, 901 Water street, Pittsburgh, Pa.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

UNITED STATES PATENTS ISSUED MAY 9, 1893.

[In Charge of W. A. Rosenbaum, 177 Times Bldg., N. Y.]

496,859. Transfer System for Telephone Switchboards; Emery A. Clark, Sioux City, Ia. Application filed June 24, 1892. By this invention each operator is provided with two or more transfer plugs, normally resting on a metallic plug strip which is connected by wire with the operator's head telephone and transmitter, and also by wire with a side contact of one or more springjacks on each of the other sections or sub-offices of the system.

496,871. Electric Meter; Oscar Ericsson, Sioux Falls, So. Dak. Application filed May 6, 1892. In an electric measuring apparatus, the combination of a plurality of separate meters adapted to measure the current in a plurality of separate circuits, of a single counting mechanism registering the sum of the current flowing through all the meters. (See illustration.)

496,878. Galvanic Battery; Chas. W. Holtzer, Brookline, Mass. Application filed Nov. 11, 1891. A removable cap or stopper for the top of a galvanic battery provided with a longitudinal passage and grooves and notches adjoining the passage as described, combined with a positive element having its upper part adapted to extend through the passage of the stopper and provided with projections to engage with the notches thereof.

496,882. Electric Arc Lamp; Martin Kruegar, Chicago, Ill. Application filed Oct. 5, 1891. The combination of the housing, the standard sustained thereby, the carbon holders, and provided with slots through which the carbons extend, and the bracket projecting from the front of the housing in position to sustain and guide the lower edge of the reflector.

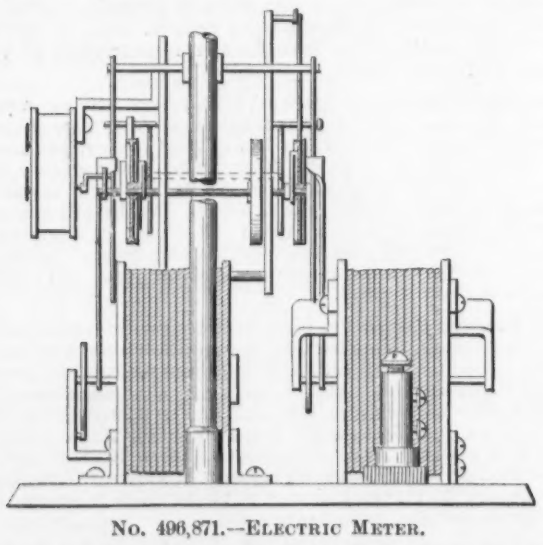
496,890. Method of Welding; Arthur J. Moxham, Johnstown, Pa. Application filed June 27, 1892. This method consists in forming the other rail with recesses in its adjacent end near its top and bottom, passing an electric current through the heads and feet of the rails, and exerting pressure on the rails.

496,896. Contact for Underground Electric Railways; Wm. Q. Prewitt, Lexington, Ky. Application filed May 19, 1892. In a contact apparatus a shank, contact device and an automatically operatable latch for connecting the contact device with the shank.

496,901. Switchboard for Electric Circuits; Albert L. Rohrer, Lynn, Mass. Application filed June 20, 1892. The combination with a switchboard having its fixed contacts arranged in slots below the surface of the insulating supporting plate, a pivoted frame carrying contact blades insulated therefrom, the blades being adapted to enter the slots.

496,904. Multiple Switchboard Apparatus; Chas. E. Scribner, Chicago, Ill. Application filed Feb. 7, 1890. In a cord switch, a frame, movable contact springs, a plug to move the springs, a lever adapted to move the springs to make a different combination of connections from that given the springs by the plug, the plug adapted to rest upon and shift the lever to its normal position when the plug is replaced in the socket.

496,905. Multiple Switchboard System; Chas. E. Scribner, Chicago, Ill. Application filed March 1, 1890. The combination with a set of contact springs to move it, and thereby the other contact springs of the switch alter their connections and a lever adapted to bear upon either of the two of the contact springs, whereby three different commutations may be effected by the cord switch.



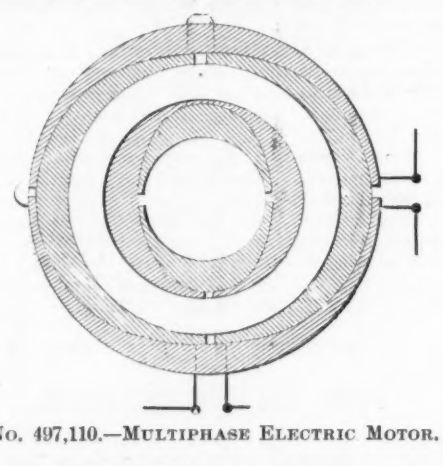
No. 496,871.—ELECTRIC METER.

496,906. Multiple Switchboard Testing Apparatus; Chas. E. Scribner, Chicago, Ill. Application filed March 1, 1890. A series or strip of cord switches having a common frame, the frame having two insulated metallic pieces and a base of insulating material projecting on opposite sides of the frame upon which base the sets of springs of the different switches are mounted, the frame being provided with a different socket and opening for each switch.

496,907. Testing Apparatus for Multiple Switchboard Systems; Chas. E. Scribner, Chicago Ill. Application filed March 24, 1890. In this invention the lines are arranged so that when connected in metallic circuit through the central office the different limbs of the two circuits will be reciprocally united, one with another, that is, the limb of one circuit which includes the springs and contacts of its switches will be connected with the limb of the other circuit which connects with the test pieces of its switches in order that the lines may test busy when thus connected together, although the subscribers may have hung up their telephones.

496,918. Safety Connections for Induction-Coil Systems; Elihu Thomson, Lynn, Mass. Application filed Oct. 3, 1888. A high tension main line, a low tension local line, an interposed converting appliance, a ground connection from the local circuit or conductors containing an interposed high resistance, and means for establishing a substitute low resistance safety connection by normally supplied high tension current of the main line escaping therefrom to the local circuit and thence to ground through the high resistance.

496,945. Electric Traveling Crane; Wm. H. Morgan, Alliance, O. Application filed June 13, 1892. The combination with a stationary operating stand or pulpit having a switch and rheostat operating devices therein for each motor circuit, a main conductor, a motor circuit leading from each switch and rheostat, and sliding contacts and conductors for each motor.



No. 497,110.—MULTIPHASE ELECTRIC MOTOR.

497,001. Method of Making Conductors for Armatures; Rookes Evelyn Bell Crompton, Chelmsford, England. Application filed March 26, 1892. This method consists in twisting together a bundle of parallel wires compressing the twisted bundle and then altering the cross-section of the ends of such twisted and compressed conductors into their required form of cross-section.

497,024. Electric Railway; Rudolph M. Hunter, Philadelphia, Pa. Application filed June 21, 1886. A sectional line conductor extending along the railway, a supply conductor also extending along the railway, electrical switches connecting the supply conductor to permit a large flow of current therein upon the passing of a vehicle, a stationary source of electric supply, an automatic regulator to control the current delivered to the supply conductor, and a return circuit also extending along the railway and connecting with the source of supply.

497,025. Overhead Electric Railway; Rudolph M. Hunter, Philadelphia, Pa. Application filed Sept. 23, 1885. This consists of a suspended working conductor, a generator of electricity electrically connected with the suspended working conductor, a traveling vehicle provided with an electric motor connected with its axle, a current collecting device moving in contact with the suspended conductor, and a current regulator to control the current supplied by the generator to the suspended working conductor.

497,038. Electric Lamp; John Waring, Manchester, Conn. Application filed Jan. 4, 1893. The combination of a carbon to be raised to incandescence by electrical excitement, an enveloping gas consisting wholly or largely of bromine, or of iodine, or both, a sealed chamber inclosing both carbon and the surrounding gas, and electrical conductors passing through the walls of this chamber and connecting with the carbon.

497,062. Shoplifting Detector; Fred Sturtevant, Charlestown, Mass. Application filed Jan. 17, 1893. This device consists of a sectional display counter, each section having a movable top-piece set in flush with the top of the frame, fulcrumed and balanced for purposes of operating an alarm or annunciator, when any pressure is applied, or any article taken therefrom in the absence of the attendant.

497,104. Automatic Switch for Mast-Arms; Wm. A. Turbayne, Detroit, Mich. Application filed Nov. 5, 1892. The combination with a swinging mast-arm, lamp and conductors therefor, of a switch and means mounted upon and independent of the mast-arm for actuating the switch upon the movement of the arm.

497,110. Multiphase Electric Motor; Paul A. N. Winand and Carl C. O. Billberg, Philadelphia, Pa. Application filed March 22, 1892. An electrical appliance for the employment or generation of multiphase alternating currents, consisting of a core wound with coils, the coils for the different currents being wound to overlap each other with turns or windings gradually diminishing in number as described. (See illustration.)

497,113. Transformer Motor; Otto Titus Blathy, Budapest, Austria-Hungary. Application filed March 24, 1891. This motor consists of two field magnets or groups thereof producing two magnetic fields independent of and not intersecting one another and having their phases displaced relatively to each other, with an armature having coils, a commutator therefor and brushes in a closed circuit containing a resistance, the armature coils being directly acted upon with an alternately inductive and dynamic action by the two field magnets, whose fields pass through the armature at different points. (See illustration.)

497,117. Magnetic Ore Separator; Chas. G. Buchanan, New York. Application filed May 17, 1892. The combination with a revolving hollow drum, a segmental series of poles arranged within the same, inducing coils therefor, feed and discharging hoppers, and an adjustable plate arranged near the periphery of the drum for controlling the supply of material thereto.

497,120. Electrical Circuit; Chas. E. Chinnock, Brooklyn, N. Y. Application filed Dec. 17, 1891. The combination of a main circuit and a non-coiled shunt forming when closed a continuous circuit with the main circuit and constructed to have a higher resistance than the main circuit and so as to be capable of conducting lightning without retardation through induction.

497,061. Electric Railway Switch; Edward F. Stone, Hyde Park, Mass. Application filed Feb. 1, 1890. A switch and mechanism embracing armature and connected with and adapted to move the switch in opposite directions, electromagnets adapted to attract the armature in opposite directions, elongated electric contacts, and an electric contact on the car for each electric contact on the roadbed.

497,123. Commutator for Electric Generators or Motors; M. W. Hassan, Rochester, N. Y. Application filed March 16, 1892. The combination, with the commutator consisting of a cylinder provided with conducting strips arranged in two spiral series diametrically opposite each other, of brush bars on opposite sides connected by cross pieces at the ends and provided with insulated rings resting on the commutator and its shaft, and two series of brushes attached to the bars by set screws.

497,144. Pedal Switch for Electric Motors; Levi Teal, Philadelphia, Pa. Application filed Jan. 16, 1893. In an electric motor controller a pedal, pedal base reversing lever pivoted at one end in the pedal base, two contact plates carried by the reversing lever, the contact plate carried by the reversing lever, contact plate having two forks, and having an arm projecting between the forks, a slide rod connected with the reversing lever and the controlling arms of the slide rod.

497,197. Portable Electric Abrading Device; Aaron J. Nellis, Pittsburgh, Pa. Application filed Dec. 12, 1892. A portable self-sustaining frame, a shaft rotatively mounted therein, with its axis at right angles to the base, a rotary tool fixed on the end of the shaft, and a motor for rotating the shaft whereby the tool is adapted to be moved over a surface and to be continuously rotated in a constant plane.

497,200. Electric Lamp Support; James Nortney and Frank Schefold, New Albany, Ind. Application filed Dec. 22, 1892. The combination with an electric lamp having a head and a support from which it is movably suspended, a switchboard fastened to the support, an aperture in the switchboard, and head-guiding mechanism upon the lamp.

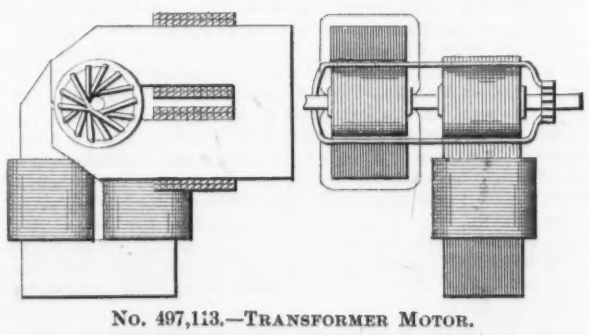
497,203. Electric Time Stock Feeder; Herbert S. Page, Medford, and Livy Spear, Boston, Mass. Application filed Oct. 12, 1892. In an electric automatic releasing device an electromagnet and armature combined with a locking link connected to the armature, and a pair of links pivoted together and to the first-mentioned link, and means for suspending and releasing a weight.

497,226. Influence Machine; Henry E. Waite, New York. Application filed Dec 5, 1892. In an influence machine, as a means for supporting the rotary plates, a screw threaded shaft, hubs mounted on the shaft engaging the plates, space blocks between the hubs, and means for clamping and adjusting the hubs and space blocks.

497,251. Coupling for Electric Light and Gas Fixtures; George Peeples, Philadelphia, Pa. Application filed Nov. 19, 1892. This invention consists of a sleeve, slot and lugs in combination with another sleeve having tongues, with recesses for interlocking the sleeves.

497,263. Electric Cigar Lighter; Wm. P. Carstarphen, Jr., Denver, Colo. Application filed Nov. 7, 1892. A transformer consisting of a spool composed of magnetic material upon which the coils are wound, an outer magnetic shell covering the coils and closing the magnetic circuit, and a cigar lighter having the burner located in the secondary circuit, and the circuit making and breaking mechanism located in the primary circuit.

497,281. Signal Transmitting Apparatus; Morris Martin, Malden, Mass. Application filed Aug. 20, 1892. The combination with a signal transmitting apparatus, of an electric circuit constituting a controlling circuit for the transmitting apparatus, having its opposite sides normally connected to the ground, and having two normally closed branches, including electromagnets; a third electromagnet in the unbranched portion of the circuit and a resistance interposed between and connecting together the ground sides of the circuit.



No. 497,113.—TRANSFORMER MOTOR.

497,293. Trolley Wire Support; H. A Hamlin, Minneapolis, Minn. Application filed June 18, 1892. The combination of a grooved plate provided with T-slots, and the wedge surfaces of the clamping plates having T-heads to be secured thereon.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886 - can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.